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NATIONAL DAM INSPECTION PROGRAM. MOOSE CREEK RESERVOIR DAM, (ND--ETC(U)
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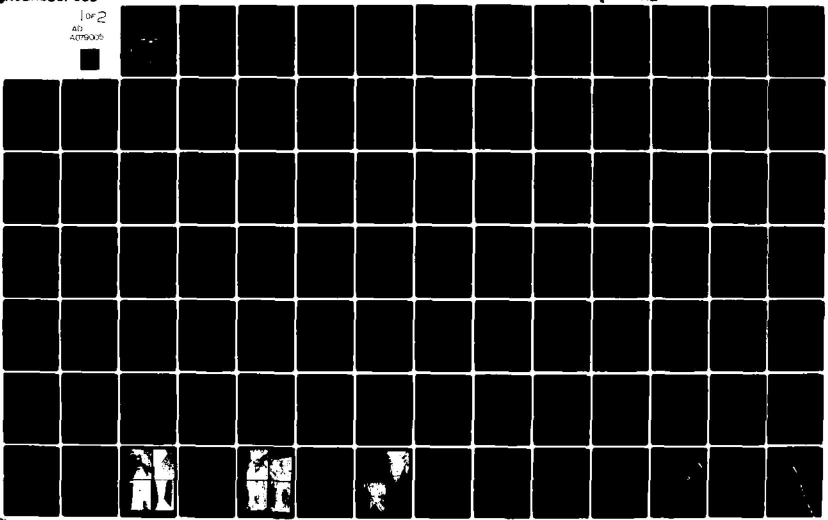

AD A079005

SUSQUEHANNA RIVER BASIN
MOOSE CREEK, CLEARFIELD COUNTY

PENNSYLVANIA

(6) National Dam Inspection Program.

MOOSE CREEK RESERVOIR DAM,

(NDS I.D. Number [redacted] PA-00423

PENNDER I.D. Number [redacted] 17-6)

Susquehanna River Basin. Moose Creek Clearfield County. Pennsylvania.

PHASE I INSPECTION REPORT.

~~NATIONAL DAM INSPECTION PROGRAM~~

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PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

PREPARED BY

GAI CONSULTANTS, INC.
570 BEATTY ROAD
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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I REPORT
National Dam Inspection Program

Abstract

Moose Creek Reservoir Dam: NDS I.D. No. PA-00423

<u>Owner</u>: Clearfield Municipal Authority

<u>State Located</u>: Pennsylvania (PennDER I.D. NO. 17-6)

<u>County Located</u>: Clearfield County

<u>Stream</u>: Moose Creek

<u>Inspection Date(s)</u>: November 16, 1978

<u>Inspection Team</u>: GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

Based on the visual inspection, operational history, and available engineering data, the dam is considered to be in fair condition.

In accordance with the recommended guidelines the spillway design flood for this facility is the Probable Maximum Flood (PMF). Results of the hydrologic and hydraulic analysis indicate that the facility is capable of passing and/or storing only 20 percent of the PMF without overtopping the embankment. Overtopping and embankment failure is also anticipated under less than 1/2 PMF flooding resulting in an increase in potential for loss of life. Thus, based on criteria contained in the recommended guidelines the spillway is considered seriously inadequate

Seepage was noted at the downstream toe in an area behind the old gate house. Also, seepage was observed to be issuing from the left embankment-abutment junction, about midway between the toe and the crest of the dam. Historical records indicate seepage was frequently noted in both areas.

General surficial deterioration is evident on portions of the spillway, particularly the sidewalls.

Because of the seriously inadequate spillway construction, the facility is considered unsafe. Failure is not considered imminent; however, it is recommended that the owner immediately develop a warning system to notify downstream residents should hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

Recent renovations have been made to the downstream appurtenances which include a new gate house and filtration system. A feasibility study for upgrading the facility is in progress. The proposed modifications if implemented would result in a substantial increase in the size of both the embankment and spillway. Should the modifications inherent to the proposal be found infeasible or not be scheduled for implementation in the immediate future, it is also recommended that the owner, with respect to the existing facility:

a. Retain a registered professional engineer to more accurately assess the adequacy of the spillway. Subsequently, the owner should take any measures deemed necessary to make the facility hydraulically adequate.

b. Install weirs under the direction of a registered professional engineer to gage seepage flow from the left embankment-abutment junction and from the area behind the old gate house. Weir readings and pool level readings should be recorded regularly. Particular attention should be focused on abrupt increases in flow and discoloration of the seepage effluent. This information with an evaluation should be transmitted to the Pennsylvania Department of Environmental Resources, Division of Dam Safety for review and comment.

c. Modify the outlet system to provide a means of controlling or blocking flow at the inlet end of the blow-off and supply lines in the event a leak(s) develops beneath the embankment.

d. Repair deteriorated portions of the spillway and provide slope protection to the channel at the end of the left wingwall.

e. Develop an operations and maintenance manual for use at the facility.

f. Have the facility inspected by a registered professional engineer experienced in the design and construction of earth dams on a yearly basis to check for hazardous conditions that might develop.

GAI Consultants, Inc.

Bernard M. Mihalcin

Bernard M. Mihalcin, P.E.

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
BERNARD M. MIHALCIN
ENGINEER
20371-E

Date 26 MAR 79

Approved by:

G. K. Withers

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date 10 Apr 79

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
MOOSE CREEK RESERVOIR DAM
NDI# PA-423, PENNDER# 17-6

SECTION 1
GENERAL INFORMATION

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Moose Creek Reservoir Dam is an earth embankment approximately 370 feet long and having a maximum height of 31 feet. The dam is provided with a concrete core wall and an uncontrolled concrete spillway with a modified ogee-shaped crest located near the right abutment.

The outlet works consist of a 24-inch diameter cast-iron blowoff and 16-inch diameter cast-iron supply pipes which pass through the core wall and are controlled via gate valves downstream of the dam.

b. Location. Moose Creek Reservoir Dam is located on Moose Creek in Lawrence Township, Clearfield County, Pennsylvania, approximately two miles northwest of the Borough of Clearfield. The dam, reservoir, and watershed are contained within the Clearfield and Elliot Park 7.5 minute U.S.G.S. topographic quadrangles (See Regional Vicinity Map, Appendix G). The coordinates of the dam are N41° 3' 20", W78° 28' 15".

c. Size Classification. Small (31 feet high, 87 acre-feet storage at maximum pool).

d. Hazard Classification. High (see Section 3.1.c.4).

e. Ownership. Clearfield Municipal Authority
107 Market Street
Clearfield, Pennsylvania 16830

f. Purpose of Dam. Water supply facility for the Borough of Clearfield.

g. Historical Data. Moose Creek Reservoir Dam was constructed in 1909-10 by Ahrens and Company of Lewistown, Pennsylvania. The dam was designed by Messrs. Knight and Hopkins of Rome, New York.

The first detailed investigation report was issued in 1914 by the Water Supply Commission of Pennsylvania (predecessor of PennDER). The Commission's Chief Engineer upon review of this report noted that "This dam appears to have been admirably designed and constructed . . .the embankment was placed under careful supervision and well compacted while the structural features of the work are in general well cared for . . ." Two problems are however alluded to in this report and subsequent reports through the 1940's. They are: 1) seepage along the toe of the dam and at the left abutment; and 2) an inadequate spillway capacity. The authority was ordered to monitor the seepage and to increase the spillway capacity on numerous occasions; however, field inspection and review of available records indicate that neither order was carried out. The seepage is still evident today, particularly at mid-embankment height on the left abutment and along the toe of the dam from the left abutment to a point just beyond the old gate house.

1.3 Pertinent Data.

a. Drainage Area. 6.4 square miles.

b. Discharge at Dam Site. Discharge records were not kept at the facility until October 1978. Currently, a daily record of flow (inches above spillway crest) is made. The maximum discharge at the facility is reported to have occurred in June 1972 (Hurricane Agnes), when approximately 33 inches of water was discharging over the spillway crest (estimated discharge ≈500 cfs).

Outlet Works Conduit at Operating Elevation - Discharge curve not available.

Spillway Capacity at Maximum Pool Elevation ≈ 1660 cfs.

c. Elevation (feet above mean sea level).

Top of Dam ≈ 1380 (Design).

Maximum Pool Design Surcharge - Not known.

Maximum Pool of Record ≈ 1376.8 in June, 1972.

Normal Pool ≈ 1374

Spillway Crest ≈ 1374

Upstream Portal Outlet Conduit Invert ≈ 1335 (estimated from Figure 3, Appendix F).

Downstream Portal Outlet Conduit Invert ≈ 1347 (estimated from Figure 3, Appendix F).

Streambed at Centerline of Dam ≈ 1350

Maximum Tailwater - Not known

d. Reservoir Length (miles).

Maximum Pool ≈ 0.3

Normal Pool ≈ 0.2

e. Storage (acre-feet).

Spillway Crest ≈ 52

Top of Dam ≈ 87

Design Surcharge - Not known

f. Reservoir Surface (acres).

Spillway Crest ≈ 4.9

Top of Dam ≈ 6.9

Maximum Design Pool - Not known

g. Dam.

Type - Earth

Length ≈ 370 feet

Height ≈ 31 feet

Top Width ≈ 20 feet

Side Slopes - upstream: 2H:1V
downstream: 1-1/2H:1V

Zoning - Earth. "Select" material placed upstream of the concrete core wall. Coarser material placed downstream of core wall. All rock over 6 inches in diameter was removed from the fill and placed along the embankment face. (See Figures 3 and 4, Appendix F).

Impervious Core - A concrete core wall extends from the foundation to elevation 1375 (see Figure 5).

Cutoff - 4-inch diameter holes on 4-foot centers were drilled 20 feet into rock and grouted under a pressure of 70 psi. The core wall trench was also excavated to variable depths into rock (see Figure 5).

h. Diversion and Regulating Tunnels. None.

i. Spillway.

Type - Uncontrolled concrete channel with a modified ogee-crested weir.

Weir Length ≈ 30 feet

Channel Length ≈ 45 feet

Crest Elevation ≈ 1374

Upstream Channel ≈ 12-inch stone paving at elevation 1370.

Downstream Channel - Natural streambed on rock downstream of the dam (see Photograph 6).

j. Outlet Conduits.

Supply Pipe - 16-inch diameter, cast-iron; length ≈ 150 feet from inlet end to upstream wall of new gate house.

Closure - Gate valve in new gate house downstream of dam. No upstream control.

Blowoff Pipe - 24-inch diameter, cast-iron; length ≈ 125 feet from inlet end to upstream wall of old gate house.

Closure - Gate valve in old gate house downstream of dam. No upstream control.

Regulating Facilities - Two gate houses with control valves are located beyond downstream toe of the dam.

Access - Both gate houses and controls are accessible and at ground level.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources.

1. Hydrology and Hydraulics. No design reports are available.

2. Embankment. Design drawings, dated 1909, are available from PennDER files. Specifications are also available from the owner.

3. Appurtenant Structures. Same as 2 (above).

b. Design Features.

1. Embankment. According to a 1915 report entitled, "Report Upon the Dam of the Clearfield Water Authority," issued by the Water Supply Commission, the embankment was constructed of selected material on the upstream side of the core wall and coarser material on the downstream side with all stones over 6 inches removed. The embankment material was spread in 12-inch layers and rolled with a tractor engine. The upstream slope is 2H:1V while the downstream slope is 1.5H:1V. The stones removed from the earth fill were placed on the slopes for riprap to a depth of 2 or 3 feet, and upon completion the stone on the downstream side was broken to a uniform size of about 3 inches for a depth of about 6 inches. In addition to the loose stone riprap, the upstream slope is protected by a well laid stone paving, 12 inches deep, extending from an elevation four feet below the flow line to four feet above; the bottom course of this paving is 24 inches deep.

The core wall was constructed of rubble concrete and is located about 5 feet upstream of the centerline of the dam. It is 2 feet thick at the top and increases 6 inches in thickness at 6-foot depth intervals to a maximum of 4 feet at the bottom and was carried about 20 feet into the abutments at each end of the dam. An "as-built" drawing dated March 30, 1915 (see Figure 5) also shows details of the core trench construction as well as 96 holes, 20 feet deep, drilled in the foundation and filled with cement grout under a pressure of about 70 pounds per square inch.

2. Appurtenant Structures.

a) Spillway. The spillway at Moose Creek Reservoir Dam is a rectangular concrete gravity structure with a modified ogee-shaped crest located on rock near the right abutment (see Figures 1 through 5 and Photograph 6). A concrete apron extends approximately 17 feet downstream of the weir where a 2-foot high concrete sill is located, thus forming a stilling basin.

b) Outlet Works. The facility is equipped with a 24-inch diameter cast-iron blowoff pipe controlled by a valve located in a gate house at the toe of the dam. In addition, a 16-inch diameter supply line is gated within a new gate house located just downstream of the old structure. The water authority has recently installed a micro-strainer on its supply system. It is housed in a metal building approximately 200 feet west of the new gate house.

2.2 Construction Records.

Daily construction records pertaining to the original facility, the original construction specifications, and approximately 20 construction photographs are available from the owner.

2.3 Operational Records.

The water supply is read daily and recorded. Spillway discharge data is available in water company files for the period October 1978 to present.

2.4 Other Investigations.

Several state inspection reports are available from PennDER. The authority has recently retained a consultant to conduct a feasibility study to enlarge Moose Creek Reservoir Dam. A previous study, conducted in 1972, concerned silt removal and modifications to the piping system. The study is available from Hill & Hill Engineers of North East, Pennsylvania.

2.5 Evaluation.

Sufficient data are available to make an accurate Phase I assessment of the facility.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the structure and related appurtenances suggest that the facility is in fair condition (see Photograph 1).

b. Embankment. The upstream face of the dam is sloped at 2H:1V and is protected by durable hand-placed sandstone riprap (see Photograph 4). The downstream face is sloped at 1.5H:1V and is mantled with gravel sized crushed stone. The crest width is approximately 20 feet.

Seepage was noted to be collecting at the toe of the dam behind the old gate house and extending to the left abutment. Much of this seepage was observed emanating from a point about mid-height of the left embankment-abutment junction. Total seepage was estimated at less than 20 GPM (see Photographs 8 and 9).

A slight bulge is evident in the crushed rock surface of the downstream slope at about mid-height. The origin of this bulge could not be ascertained though it is mentioned in old state inspection reports.

c. Appurtenant Structures.

1. Spillway. The spillway, spillway sidewalls, and stilling basin all appeared to be in fair condition. Moderate to severe scaling was evident below the flow line of the spillway weir and sidewalls. Spalling was noted at several construction joints and pattern cracking with slight efflorescence was observed on the left wingwall (see Photograph 6). Some erosion is evident at the end of the left spillway wingwall where the channel protection appears insufficient.

2. Gate Controls, Blowoff, and Supply Line. Since original construction, the outlet pipes have been controlled by gate valves operated from a concrete valve house at the toe of the dam. Figure 5 indicates that the 24-inch diameter blowoff and 16-inch diameter supply pipes pass beneath the dam in a trench cut into soil.

Recently the authority constructed a new gate house just downstream of the old structure. Discharge through the supply line is now controlled from within this structure. Discharge though the blowoff is still controlled from the old gate house; however, a corrugated metal pipe has been added to the discharge end (see Photograph 7).

Details of the original outlet system are shown on Figure 3.

3. Reservoir Area. The valley slopes adjoining Moose Creek Reservoir are steep and heavily wooded. (see Photograph 3). No indications of slope distress were observed at the time of the inspection. Sandstone ledges are visible on both abutments above the dam crest.

4. Downstream Channel. The area immediately downstream of Moose Creek Reservoir Dam is characterized as a narrow wooded valley containing Moose Creek (see Photograph 5). Approximately one mile downstream, Moose Creek passes through a highway embankment of U. S. Route 322 just northwest of Clearfield (see Regional Vicinity Map, Appendix G). One dwelling (see Photograph 10) is located along Moose Creek about 500 feet upstream of the highway embankment and, approximately 4,800 feet from the dam. Downstream of the highway embankment there are numerous homes located along the stream banks. Fifteen to 20 persons are estimated to be residing in an area of potential flooding from a breach of the Moose Creek embankment. Consequently, the facility is placed in a "high" hazard category.

3.2 Evaluation.

The dam and its appurtenances are in fair condition. Seepage was observed at the toe of the dam from the area behind the old gate house to the left abutment. A general surficial treatment of exposed concrete surfaces is required and channel protection at the end of the left spillway wingwall appears insufficient.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

Excess inflow is discharged over the spillway located near the right abutment. The supply line is kept open and an automatic recorder measures usage. According to water company personnel, the blowoff line is also kept opened slightly to prevent silting at the upstream end and to keep the reservoir from undergoing inversion.

4.2 Maintenance of Dam.

There is no maintenance manual or formal maintenance program concerning the dam. According to water company personnel, the embankment is cleared of vegetation yearly. Other maintenance is provided on an unscheduled basis.

4.3 Maintenance of Operating Facilities.

The site is visited daily by an operator responsible for Moose Creek and other water authority reservoirs. Operating equipment is checked periodically and is maintained as necessary.

4.4 Warning Systems.

There are no formal warning systems in effect at the site.

4.5 Evaluation.

No formal operational or maintenance procedures are established for the facility. The water authority employs a "Dam Operator" responsible for the maintenance and operation of Moose Creek Reservoir Dam. Except for some deterioration of concrete surfaces, the dam and appurtenances appeared to be well maintained. Manuals of operation and maintenance should be formalized and an emergency warning system is required.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No hydrologic or hydraulic design data are available.

5.2 Experience Data.

No formal records of the flow through the emergency spillway and/or outlet works were kept relative to this facility, prior to October 1978. Owners representatives indicated that the maximum flow of record, approximately 33 inches over the spillway crest, occurred in June, 1972. There are no indications that the embankment has ever been overtopped.

5.3 Visual Observations.

On the date of the inspection, no conditions were observed that would indicate the appurtenant structures of the dam could not operate satisfactorily within the limits of their design during a flood event.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U. S. Army Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U. S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix C.

5.5 Summary of Analysis

a. Spillway Design Flood (SDF). In accordance with the procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Moose Creek Reservoir Dam ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF, based on its relative size (small) and on the potential hazard of dam failure on downstream developments (high). Due to the high potential for damage to many residences as well as to a main highway embankment, the SDF for this facility is considered to be the PMF.

b. Results. The Moose Creek Reservoir Dam was analyzed such that the reservoir level was initially at its normal pool or service-emergency spillway elevation (≈ 1374.0 ft). The spillway weir was observed to have an ogee-like crest shape and was treated as such. Also, the downstream routing channel passes beneath a large highway embankment (U.S. Route 322 located about one mile downstream of the dam) prior to crossing through the major portion of the immediate downstream residential area, and was assumed to function as a dam (with its own discharge rating curve and elevation-storage relationship; sheets 12-18, Appendix C) in the analysis. The downstream channel was further assumed to be dry preceding routing, as instructed by personnel of the U. S. Army Corps of Engineers, Baltimore District. All pertinent engineering calculations relative to the evaluation of the Moose Creek Reservoir Dam are provided in Appendix C.

Overtopping Analysis (using the Modified HEC-1 computer program) of the Moose Creek Reservoir Dam facility indicated that only about 20 percent of the PMF could be stored and/or discharged by the spillway before overtopping of the embankment occurred (Appendix C, Summary Input/Output Sheets, Sheet G). The computer output disclosed that a water depth of about 2.9 feet would inundate the dam during the peak of the PMF, and a depth of about 1.4 feet would flow over the dam during the peak of the 1/2 PMF. Further, the dam would be overtopped for a duration of about 8.8 hours during the PMF, and about 7.3 hours during the 1/2 PMF. Therefore, Moose Creek Reservoir Dam has a high potential for overtopping, and consequently, for breaching.

Since the spillway cannot safely pass a flood of at least 1/2 PMF magnitude (the SDF of the dam is the full PMF), the possibility of failure of the embankment from overtopping when subjected to floods of 1/2 PMF intensity or less was investigated (in accordance with ETL-1110-2-234). Since it is difficult, if not impossible, to determine exactly how or if a specific dam will fail, several possible alternatives were evaluated. The major concern of the evaluations was the impact of the various breach discharges on the downstream communities.

The Modified HEC-1 Program was used to generate the possible results of dam breaching due to downcutting by the overtopping waters. Breaching due to piping could not be analyzed directly, even though field investigation revealed the existence of seepage along the left abutment embankment-rock contact which indicates that piping could be an important factor during failure.

It was assumed, for the purpose of analysis, that breaching would begin once the reservoir water level reached the top of dam elevation. This assumption was based on the opinion that any amount of overtopping can potentially fail an earth dam, since there are so many unknown factors that can contribute to the failure process. An additional overall assumption was that a breach section would propagate downward to a depth equal to the height of the embankment fill (28 ft.), since the impounded Moose Creek should tend to seek the previous equilibrium level which it had attained prior to the construction of the dam (if at all possible).

Two sets of breach geometry were evaluated for each of two failure times (Appendix C, sheets 19 and 20). The two sets of breach sections chosen were considered to be the minimum and maximum probable failure sections. The two failure times (total time for each breach section to reach its final dimensions) under which the minimum and maximum sections were investigated were assumed to be near instantaneous (15 minutes) and prolonged (4 hours), so that the possible upper and lower limits of this most sensitive variable might be examined. The near instantaneous failure time was evaluated due to the presence of a concrete core wall. (Although the top of the concrete core wall of Moose Creek Reservoir Dam was actually covered by 5 feet of earth, it was assumed that the wall extended to the top of the dam in the analysis.

In addition to the above breach conditions, an average or more probable condition was analyzed. This condition was such that the breach section was intermediate to the minimum and maximum breach configurations previously mentioned. The failure time for this breach geometry was also intermediate to the two failure times previously mentioned, but closer to the near instantaneous time since it was felt that the core wall was probably in fair to good shape.

The five breaching schemes were investigated under each of two flooding situations, the 1/2 PMF and the 3/10 PMF. The 1/2 PMF resulted in a 1.4-ft depth of flow over the dam if breaching did not occur, and the 3/10 PMF resulted in about a 0.5-ft depth of flow over the dam. It is possible that either depth of flow could cause failure of the dam, although the probability of failure is greater for the 1/2 PMF due to the larger volume of overtopping water corresponding to that flood. However, the more frequent 3/10 PMF event will lead to lesser downstream base flooding conditions, since the non-breach peak flow of the 1/2 PMF is so much greater than that of the 3/10 PMF.

The near instantaneous failures produced the largest breach outflows under both the 1/2 and 3/10 PMF inflow conditions. The prolonged failure peak outflows were slightly larger than the average failure peak outflows in the 1/2 PMF breach analysis, with the opposite trend occurring in the 3/10 PMF analysis (Appendix C, sheet 21). The average or more probable mode of failure provided peak breach discharges of 3770 cfs and 3590 cfs under 1/2 and 3/10 PMF conditions, respectively. However, the actual peak discharge which occurred during the 1/2 PMF average breach analysis was 4120 cfs, due solely to the passing of the 1/2 PMF peak inflow through the already breached dam.

If the adequacy of the dam's spillway was based solely on breaching under the 1/2 PMF event, analysis would indicate that the spillway of the dam was merely inadequate. This is based on the fact that the 1/2 PMF would cause serious flooding downstream even without breaching of the dam. The potential additional increase in the downstream water surface elevation caused by breaching under 1/2 PMF conditions is a maximum of about 0.5 ft at the first structure located 4300 ft downstream of the dam and 0.5 ft at a section located 6100 ft downstream of the dam, considering a maximum, near instantaneous breach. The additional increase in the downstream water surface elevations considering the 1/2 PMF, more probable breach conditions is 0.0 ft at both previously mentioned routing sections (Appendix C, sheet 22). Assuming that the more probable breach conditions are most representative of all possible breach conditions, failure of the dam should not pose a serious threat to increase the loss of life or property damage downstream above that which should be caused by the 1/2 PMF alone.

Since the 3/10 PMF can also potentially cause the dam to fail and it is a more frequently occurring event, its breaching analysis must be considered with more weight than the 1/2 PMF breaching analysis. The maximum 3/10 PMF non-breach water surface elevations were such that the flood did not reach the estimated first floor elevation of the buildings at the section located 6100 feet downstream of the dam. On the other hand, if the dam failed during the 3/10 PMF event, the water surface elevation at the above mentioned section would increase by about 2 ft (considering the more probable mode of failure), which corresponds to a depth of about 1.5 ft above the first floor elevation. The consequences of the dam breaching under these conditions can be better envisioned if not only the increase in the height of the floodwave is considered, but also the increased momentum that the larger and probably swifter moving volume of water will possess. Therefore, the failure of Moose Creek Reservoir Dam is quite possible, and, for higher frequency (but still potentially dangerous) floods, will most probably lead to increased loss of life and property damage in the downstream communities.

5.6 Spillway Adequacy.

As presented previously, under existing conditions Moose Creek Reservoir Dam can pass approximately 20 percent of the PMF prior to overtopping. Should a 3/10 PMF event occur, the dam will be overtopped and will possibly fail, endangering several residences of the downstream community. Therefore, the spillway of Moose Creek Reservoir Dam is considered to be seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the embankment appeared to be in fair condition. Seepage was observed, issuing from a point at about mid-height on the left abutment-embankment junction as well as at the dam toe behind the old gate house.

Some slight bulging of the rock surface on the downstream face was also observed. This condition is thought to be the surficial sliding of the relatively steep rock surface that was mentioned in old state inspection reports.

b. Appurtenant Structures. Aside from the spillway, the only portions of the outlet system observed at the time of inspection were the control valves for the blowoff and supply lines and the discharge end of the 24-inch diameter blowoff pipe. The new control building, constructed in 1972, appeared in excellent condition.

Moderate to severe scaling was evident below the flow line on the modified ogee crest and on the spillway sidewalls. Spalling was noted at some construction joints and pattern cracking was evident on the left wingwall. Some erosion was evident at the end of the left spillway wingwall, adjacent to the embankment toe.

6.2 Design and Construction Techniques.

Design computations or reports were not available for any aspect of this facility. Contract specifications, construction progress reports, and photographs of the original construction are available from the owner.

6.3 Past Performance.

The visual inspection indicates that the facility has performed adequately in the past. The record pool level at the facility reportedly occurred during the "Agnes" storm of 1972 when the depth of flow over the spillway crest reportedly measured 33 inches.

6.4 Seismic Stability.

The dam is located within Seismic Zone No. 1 and may be subject to minor earthquake induced dynamic forces. Historical reports and construction records indicate the embankment was placed in thin lifts, wetted as needed, and mechanically compacted. Thus, it is believed that the embankment can withstand the expected minor earthquake induced forces. However, no calculations or investigations were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual inspection, operational history, and available engineering data suggest that the dam and its appurtenances are in fair condition. Hydraulic and hydrologic calculations made during our investigation indicate that the spillway is capable of passing and/or storing 20 percent of the PMF without overtopping. Based on screening criteria supplied by the Department of the Army, Office of Chief of Engineers, the spillway is classified as "seriously inadequate."

Seepage (less than 20 GPM) was observed issuing from the left abutment-embankment contact and from a point behind the old gate house. Seepage has been noted historically at these locations.

Discharge through the 16 and 24-inch diameter cast-iron outlet pipes cannot be controlled at the inlet end; consequently, these pipes are under full hydrostatic head at all times and should a leak develop within the pipes beneath the dam, discharge could not be controlled.

b. Adequacy of Information. The available data is considered sufficient to make an accurate Phase I assessment of the facility.

c. Urgency. Because of the seriously inadequate spillway, a formal warning system should be immediately implemented. Other studies and remedial action should be implemented without undue delay.

d. Necessity for Additional Investigations. The additional investigations listed below are considered necessary if major renovations presently being contemplated by the owner and its consultant are determined to be infeasible or are not scheduled for immediate implementation.

7.2 Recommendations/Remedial Measures.

Because of the seriously inadequate spillway construction, the facility is considered unsafe. Failure is not considered imminent; however, it is recommended that the owner immediately develop a warning system to notify downstream residents should hazardous conditions develop.

Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

Recent renovations have been made to the downstream appurtenances which include a new gate house and filtration system. A feasibility study for upgrading the facility is in progress. The proposed modifications if implemented would result in a substantial increase in the size of both the embankment and spillway. Should the modifications inherent to the proposal be found infeasible or not be scheduled for implementation in the immediate future, it is also recommended that the owner, with respect to the existing facility:

a. Retain a registered professional engineer to more accurately assess the adequacy of the spillway. Subsequently, the owner should take any measures deemed necessary to make the facility hydraulically adequate.

b. Install weirs under the direction of a registered professional engineer to gage seepage flow from the left embankment-abutment junction and from the area behind the old gate house. Weir readings and pool level readings should be recorded regularly. Particular attention should be focused on abrupt increases in flow and discoloration of the seepage effluent. This information with an evaluation should be transmitted to the Pennsylvania Department of Environmental Resources, Division of Dam Safety for review and comment.

c. Modify the outlet system to provide a means of controlling or blocking flow at the inlet end of the blow-off and supply lines in the event a leak(s) develops beneath the embankment.

d. Repair deteriorated portions of the spillway and provide slope protection to the channel at the end of the left wingwall.

e. Develop an operations and maintenance manual for use at the facility.

f. Have the facility inspected by a registered professional engineer experienced in the design and construction of earth dams on a yearly basis to check for hazardous conditions that might develop.

APPENDIX A

CHECK LIST
ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM: Moose Creek Reservoir Dam

NDI#: PA-423 PENNDER# : 17-6

ITEM	REMARKS NDI# PA - 423
PERSONS INTERVIEWED AND TITLE	Site Visit: 1. Jeff Williams - Manager 2. James Jones - Operator of Dam 3. Doug Rhone - Assistant Manager Others (via phone): 1. John Hallenburg Hill and Hill Engineers, North East, PA (present consultant to water authority)
REGIONAL VICINITY MAP	U.S.G.S. 7.5 minute series topographic quadrangle Clearfield, PA (see Appendix G).
CONSTRUCTION HISTORY	Compiled from PennDER files. Excellent summary report from 1915.
AVAILABLE DRAWINGS	1. Detailed linens and blue prints (construction and as-built) at authority office. Also available from PennDER files. 2. Hill and Hill Engineers also have reproducibles. 3. Set of 4 drawings in 1972 by Hill and Hill Engineers - Good plan. 4. Set of 4 drawings available from PennDER files (see Figures 2 through 5, Appendix F).
TYPICAL DAM SECTIONS	See Figures 3 and 4.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	 See Figure 3. See Figure 3. None.

ITEM	REMARKS NDI# PA - 423
SPILLWAY: PLAN SECTION DETAILS	See Figure 4. See Figure 4. See Figure 4.
OPERATING EQUIPMENT PLANS AND DETAILS	24-inch diameter blowoff pipe. See Figure 3. 16-inch diameter supply pipe.
DESIGN REPORTS	No design reports available. Clearfield Water Authority has daily construction reports from 1910, original construction specifications and about 20 construction photographs.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available.
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	Consultants for the Water Authority have recently drilled the site in order to prepare a feasibility study on enlarging the reservoir. All borings are downstream of existing facility (see Figures 7 and 8).

ITEM	REMARKS NDI# PA - 423
BORROW SOURCES	Not known.
POST CONSTRUCTION DAM SURVEYS	1. Reservoir sounded in 1972 (prior to Agnes storm) for de-silting. 2. None specifically to determine settlement of dam. 3. Survey performed to locate borings and deep wells.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	1. Engineering study by Hill and Hill Engineers of North East, PA in January 1972 for removal of silt and some modifications of piping system. 2. Drilled in 1974 for Hill and Hill Engineers for feasibility study to enlarge Moose Creek Dam (10 borings - No records at Clearfield Office). 3. Deep wells installed to monitor stripping contamination in 1974. (Benjamin Coal Company).
HIGH POOL RECORDS	June 1972 ≃ 33 inches over spillway (Hurricane Agnes).
MONITORING SYSTEMS	1. Flow meter and recorder on supply line. 2. Spillway flow manually measured for months of October-November, 1978. 3. Rain gage at reservoir in adjacent watershed. 4. Chlorine weighing station.
MODIFICATIONS	1. New control building built in 1972. 2. Added micro-strainer in 1978. 3. Feasibility study being conducted presently to increase size of facility.

ITEM	REMARKS NDI# - PA 423
PRIOR ACCIDENTS OR FAILURES	None.
MAINTENANCE: RECORDS MANUAL	Records - None kept 1. Slopes cleared annually. 2. Oil valves, etc. - unscheduled. Manual - None.
OPERATION: RECORDS MANUAL	Records - Daily rainfall (in adjacent watershed); chlorine; flouride and water usage records kept. Have also been recording depth of spillway flow since October, 1978. Manual - None.
OPERATIONAL PROCEDURES	1. Blowoff always open to some extent to keep inlet cleared and prevent inversion. 2. Standard procedures for adding chlorine and flouride. 3. Otherwise self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None - Working out program with Civil Defense System.
MISCELLANEOUS	Cleaned reservoir via front end loader (average 30 inches of sediment) prior to Agnes (1972).

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-423
PENN DER ID # 17-6

SIZE OF DRAINAGE AREA: 6.4 square miles

ELEVATION TOP NORMAL POOL: 1374 STORAGE CAPACITY: 52 acre-feet

ELEVATION TOP FLOOD CONTROL POOL: Not known STORAGE CAPACITY: Not known

ELEVATION MAXIMUM DESIGN POOL: Not known STORAGE CAPACITY: Not known

ELEVATION TOP DAM: 1380 STORAGE CAPACITY: 87 acre-feet

SPILLWAY DATA

CREST ELEVATION: 1374

TYPE: Modified ogee

WIDTH: 5 feet

LENGTH: 30 feet

SPILLOVER LOCATION: right abutment

NUMBER AND TYPE OF GATES: None

OUTLET WORKS

TYPE: 24-inch diameter cast-iron blowoff 16-inch diameter cast-iron supply pipe

LOCATION: ≈165 feet right of left abutment

ENTRANCE INVERTS: Approximately El 1355 (scaled from Fig. 3, App. F)

EXIT INVERTS: Approximately El 1347 (scaled from Fig. 3, App. F)

EMERGENCY DRAWDOWN FACILITIES: 24-inch diameter cast-iron blowoff regulated from within the old gate house.

HYDROMETEOROLOGICAL GAGES

TYPE: Rain gage

LOCATION: Montgomery Dam - next watershed west

RECORDS: Daily rainfall records available from owner

MAXIMUM NON-DAMAGING DISCHARGE: 33 inches over spillway, June 1972 (Agnes).

APPENDIX B

CHECK LIST
VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Moose Creek Reservoir Dam STATE Pennsylvania COUNTY Clearfield

NDI# PA - 423 PENNDER# 17-6

TYPE OF DAM Earth w/concrete spillway SIZE small HAZARD CATAGORY High

DATE(S) INSPECTION 16 November 1978 WEATHER Overcast TEMPERATURE 45° @ 10:30 AM ~~PM~~

POOL ELEVATION AT TIME OF INSPECTION 1374.1 M.S.L.

TAILWATER AT TIME OF INSPECTION 1362.1 M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	OTHERS
B. M. Mihalcin	Jeff Williams - Manager	
J. P. Nairn	James Jones - Operator	
E. J. Mannella	Doug Rhone - Assistant Manager	
W. J. Veon		

RECORDED BY B. M. Mihalcin

EMBANKMENT

ITEM	OBSERVATIONS AND/OR REMARKS NDI# PA - 423
SURFACE CRACKS	None observed.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Slight bulging along entire downstream face at mid-slope. (No seepage observed through face.)
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal - good. Vertical - Fair; slight depression apparent approximately 130 feet from left abutment. Field survey indicated settlement insignificant.
RIPRAP FAILURES	None. 4- to 6-inch thick sandstone slabs (durable) - hand placed.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good on both abutments. See Page 3 for seepage.

EMBANKMENT

ITEM	OBSERVATIONS AND/OR REMARKS NDI# PA - 423
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	Sphagnum moss along downstream toe - starts about mid-height along left abutment-embankment junction and continues to toe of dam behind old gate house.
ANY NOTICEABLE SEEPAGE	Seepage along toe. Starts at mid-height and continues along left abutment to old gate house. No seepage noted through face of dam.
STAFF GAGE AND RECORDER	Staff gage - None. Flow meter in new gate house.
DRAINS	None observed.
MISCELLANEOUS	Downstream face covered by well graded crushed sandstone 3 to 6 inches in diameter.

OUTLET WORKS

ITEM	OBSERVATIONS AND/OR REMARKS NDI# PA - 423
INTAKE STRUCTURE	Submerged.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	A 24-inch CMP section was recently added to original C. I. blowoff pipe and exits into old stream channel.
OUTLET STRUCTURE	None. 24-inch diameter blowoff controlled from within the old gate house. 18-inch diameter supply line controlled from within the new gate house.
OUTLET CHANNEL	Empties into spillway channel approximately 50 feet downstream of discharge end of CMP.
GATE(S) AND OPERATIONAL EQUIPMENT	Blowoff pipe controlled from within the old gate house. Supply pipe open in old gate house and controlled via valves located in the new gate house. No valves or controls on upstream side of embankment.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS AND/OR REMARKS NDI# PA - 423
TYPE AND CONDITION	Concrete - Modified ogee. Condition - Good, but in need of surficial repair.
APPROACH CHANNEL	Riprap-lined and unobstructed.
SPILLWAY CHANNEL AND SIDEWALLS	Channel - Moderate to severe scaling of concrete below flow line on sidewalls and along ogee-like crest. Sidewalls - Slight spalling at construction joints; slight efflorescence and pattern cracking on left wingwall; good alignment.
STILLING BASIN PLUNGE POOL	Good condition. Apron below plunge pool - Good condition.
DISCHARGE CHANNEL	Discharge into natural stream (rock base). Some erosion at end of left wingwall - Should be protected by rock riprap.
BRIDGE AND PIERS	None.
EMERGENCY GATES	None.

SERVICE SPILLWAY

ITEM	OBSERVATIONS AND/OR REMARKS NDI# PA - 423
TYPE AND CONDITION	See Emergency Spillway.
APPROACH CHANNEL	See Emergency Spillway.
OUTLET STRUCTURE	See Emergency Spillway.
DISCHARGE CHANNEL	See Emergency Spillway.

INSTRUMENTATION

NDI# PA - 423

ITEM	OBSERVATIONS AND/OR REMARKS
MONUMENTATION SURVEYS	None.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None.
OTHERS	Flow meter on supply line in new gate house.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS AND/OR REMARKS NDI# PA - 423
SLOPES: RESERVOIR	Steep; heavily wooded, no signs of slope distress.
SEDIMENTATION	Owner's representatives state that substantial sediment load resulted from 1972 flood. No surveys have been conducted to gate the actual amount.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Natural stream channel - unobstructed but tree lined; moderate grade.
	Moderate to steep valley slopes, densely forested. First house about 3,800 feet from dam. Highway embankment about 5,600 feet from dam (U. S. Route 322). Many homes along stream from about 500 feet downstream of highway bridge.
APPROXIMATE NUMBER OF HOMES AND POPULATION	At least one-half dozen homes could be affected by a dam breach, depending upon the water level in the stream prior to failure. Population ≈ 15 to 20.

APPENDIX C

HYDROLOGY AND HYDRAULICS

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

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DAM STATISTICS

HEIGHT OF DAM ≙ 31 FEET (FIELD MEASURED)

MAXIMUM POOL STORAGE CAPACITY ≃ 87 AC-FT @ TOP OF DAM [OBTAINED FROM HEC-1 OUTPUT]

NORMAL POOL STORAGE CAPACITY ≃ 52.2 AC-FT (SEE NOTE 1)

DRAINAGE AREA ≃ 6.4 SQ. MI. [PLANIMETERED OFF U.S.G.S. 7.5 MINUTE SERIES QUADS ELLIOT PARK & CLEARFIELD]

NOTE 1: STORAGE CAPACITY VALUE FROM "REPORT UPON THE DAM OF THE CLEARFIELD WATER COMPANY ACROSS MOOSE CREEK, LAWRENCE TOWNSHIP, CLEARFIELD COUNTY, PA." (1915). STORAGE CAPACITY REPORTED TO BE 17,000,000 GALLONS. INFORMATION AVAILABLE FROM PENNDER.

DAM CLASSIFICATION

DAM SIZE - SMALL (REF 1, TABLE 1)

HAZARD CLASSIFICATION - HIGH (FIELD OBSERVATION)

REQUIRED SDF - ½ PMF TO PMF (REF 1, TABLE 3)

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HYDROGRAPH PARAMETERS

LENGTH OF LONGEST WATERCOURSE $(L) \simeq 5.9$ MILES

$L_{CA} \simeq 2.9$ MILES (MEASURED FROM DAM CREST TO CENTROID OF BASIN)

NOTE 2: VALUES OF L AND L_{CA} ARE MEASURED FROM U.S.G.S 7.5 MINUTE SERIES QUADS ELLIOT PARK AND CLEARFIELD

$C_t = 1.84$

$C_p = 0.45$

[SUPPLIED BY C OF E; ZONE 19, SUSQUEHANNA RIVER BASIN]

t_p = SNYDER'S STANDARD LAG = $1.84(L \times L_{CA})^{0.3}$

$$t_p = (1.84)\left[(5.9)(2.9)\right]^{0.3} = 4.31$$

RESERVOIR SURFACE AREAS

S.A. (SURFACE AREA) @ NORMAL POOL EL 1374.0 $\simeq$ 4.9 ACRES (PLANIMETERED FROM REF. FIG 2, APP. F)

S.A. @ EL 1400.0 $\simeq$ 13.8 ACRES [PLANIMETERED OFF U.S.G.S. 7.5 MINUTE SERIES QUADS ELLIOT PARK & CLEARFIELD]

RATE OF AREA CHANGE PER FOOT OF RISE (ABOVE EL. 1374.0) $\simeq \dfrac{13.8 - 4.9}{1400 - 1374} \simeq 0.34$ AC/FT

TOP OF DAM @ EL. 1380.0 (REF FIG 3, APP. F)

$\therefore$ SA @ TOP OF DAM $\cong \left[(1380.0 - 1374.0) \times 0.34 \text{ AC/FT}\right] + 4.9$ ACRES
$\cong 6.9$ ACRES

SUBJECT DAM SAFETY INSPECTION
— MOOSE CREEK RESERVOIR
BY DLB DATE 1-18-79 PROJ. NO. 78-617-423
CHKD. BY WJV DATE 1/24/79 SHEET NO. 3 OF 22

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RESERVOIR ELEVATION @ "O" STORAGE

NORMAL POOL VOLUME = 1/3 HA = 52 AC-FT (CONIC METHOD)

S.A. @ NORMAL POOL EL 1374.0 ≃ 4.9 ACRES (SHEET 2)

$$H = \frac{(3)(52 \text{ AC-FT})}{(4.9 \text{ AC})} = 31.8 \text{ FT}$$

ZERO VOLUME ELEVATION = 1374.0 - 31.8 = 1342.2 FT (SEE NOTE 3)

NOTE 3: ACTUAL MINIMUM ELEVATION @ "O" STORAGE ≃ 1351 ACCORDING TO FIGURE 2, APPENDIX F. HOWEVER, IN ORDER TO COMPUTE A STORAGE-ELEVATION RELATIONSHIP AND STILL MAINTAIN A STORAGE OF 52 AC-FT @ EL 1374.0, THE ABOVE "O" STORAGE ELEVATION OF 1342.2 MUST BE INPUT INTO THE HEC-1 PROGRAM.

STORAGE - ELEVATION RELATIONSHIP

COMPUTED INTERNALLY BY THE HEC-1 PROGRAM BASED ON GIVEN SURFACE AREA VS ELEVATION INFORMATION. (SEE SUMMARY INPUT/OUTPUT SHEETS)

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PMP CALCULATIONS

STANDARD RAINFALL INDEX = 22.2 INCHES (REF 9, FIG 2)
(CORRESPONDING TO A DURATION OF 24 HRS AND AN AREA OF 200 SQ. MI.)

GEOGRAPHIC ADJUSTMENT FACTOR = 103% (REF 9, FIG 1)
(CORRESPONDING TO A LONGITUDE OF 78° 28' AND A LATITUDE OF 41° 03')

CORRECTED RAINFALL INDEX = (22.2 INCHES)(1.03) = 22.9 INCHES

DRAINAGE AREA ≃ 6.4 SQ. MI. < 10 SQ. MI. ⟹ ASSUME 10 SQ. MI. DATA CAN EFFECTIVELY REPRESENT THE 6.4 SQ. MI. AREA.

DURATION (HOURS)	PERCENT OF INDEX RAINFALL (%)
6	117.5
12	127.0
24	136.0

NOTE: A 24-HR RATHER THAN A 72-HR DURATION WAS USED SO THAT A TIME STEP OF 5 MINUTES COULD BE USED IN THE HEC-1 PROGRAM.

- HOP BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE, AS WELL AS FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALLER AREA) CORRESPONDING TO A D.A. = 6.4 SQ. MI. (< 10 SQ. MI.) = 0.80
(REF 4, PG 48)

SUBJECT: DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY: DLR | DATE: 12-21-79 | PROJ. NO. 78-617-423
CHKD. BY: WJV | DATE: 12-24-79 | SHEET NO. 5 OF 22

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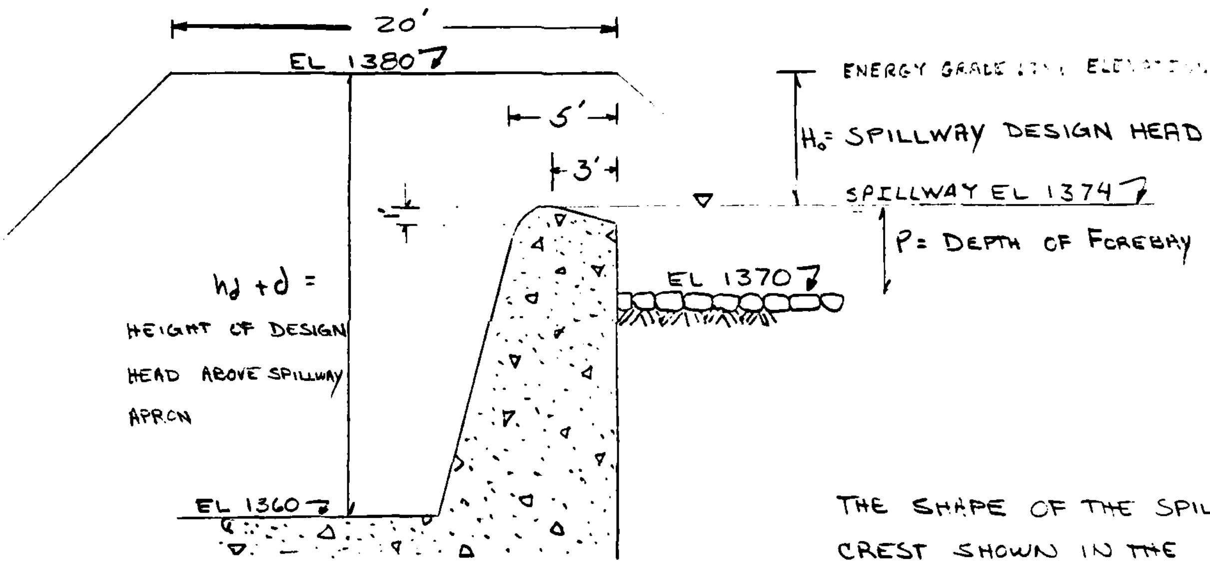
SPILLWAY CAPACITY:

SPILLWAY DIMENSIONS AND ELEVATIONS ARE TAKEN FROM FIGURE 4, APPENDIX F AND HAVE BEEN FIELD VERIFIED.



(SCALE 1 IN = 8 FT)

THE SHAPE OF THE SPILLWAY CREST SHOWN IN THE ADJACENT FIGURE IS VERY SIMILAR TO THAT OF AN OGEE-SHAPED CREST. ∴ ASSUME THAT THE ACTUAL DISCHARGES OVER THE ABOVE WEIR CAN BE APPROXIMATED BY THOSE OVER AN OGEE-SHAPED WEIR WITH:

$$Q = CLH^{3/2}$$

WHERE Q = TOTAL DISCHARGE (CFS)

C = COEFFICIENT OF DISCHARGE

L = LENGTH OF CREST (FT) = 30 FT (FIG 4, APPENDIX F)

H = TOTAL HEAD (FT)

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY DLB DATE 1-19-79 PROJ. NO. 78-617-423
CHKD. BY WJV DATE 1-24-79 SHEET NO. 6 OF 22

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APPROACH CHANNEL ≃ 20 FT LONG AND 30 FT WIDE

FOREBAY DEPTH (P) = 4 FT

ASSUMED DESIGN HEAD (TOTAL POSSIBLE HEAD) = 6 FT

UPSTREAM SLOPE OF OGEE = 3H TO 1V

SEE FIGURE 4 APPENDIX F

COEFFICIENT OF DISCHARGE (C) $\Rightarrow P/H_o = 4'/6' = 0.67$

$\therefore \quad C = 3.85$ (REF 4, pg 378)

C CORRECTED TO ACCOUNT FOR UPSTREAM SLOPE OF OGEE = 3.85
SLOPE EFFECT IS NEGLIGIBLE (REF 4, pg 379)

CALCULATE APPROACH LOSSES :

ESTIMATE THE FLOW PER FOOT OF WEIR LENGTH

$q = CH^{3/2} = 3.85\,(6)^{3/2} = 56.6$ CFS/FT

$\therefore$ VELOCITY OF APPROACH CHANNEL $= q/(H_o + P) = (56.6 \text{ CFS/FT})/(4+6)\text{FT}$

$= 5.66$ FT/SEC

APPROACH VELOCITY HEAD $= V_a^2/2g = \dfrac{(5.66)^2}{2g} = 0.5$ FT

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APPROACH CHANNEL LOSS (BY MANNING'S EQUATION)

$$= 20' \times \left(\frac{V_a n}{1.49 R^{2/3}}\right)^2$$ (REF 13, pg 143)

where $n \simeq 0.033$ (DRY RUBBLE MASONRY; REF 7, pg 111)

$$R = \frac{\text{AREA OF FLOW}}{\text{WETTED PERIMETER}} = \frac{(10')(30')}{(10'+10'+30')} = 6.0'$$

$$\text{CHANNEL LOSS} = (20')\left[\frac{(5.66)(0.033)}{(1.49)(6)^{2/3}}\right]^2 = 0.03'$$

ASSUMING ENTRANCE LOSS TO BE $0.1\,(V_a^2/2g)$ (REF 4, pg 379)

TOTAL APPROACH LOSS $= 0.1(0.5) + 0.03 = 0.08$ FT (SAY 0.10 FT)

$\therefore$ ACTUAL EFFECTIVE HEAD = DESIGN HEAD − LOSSES $= 6.0 - 0.1 = 5.9$ FT

$\Rightarrow P/H = 4/5.9 = 0.68 \Rightarrow C = 3.85$ (NEGLIGIBLE CHANGE IN DISCHARGE COEFFICIENT DUE TO APPROACH LOSSES)

CALCULATE DOWNSTREAM APRON EFFECTS:

DOWNSTREAM APRON ELEVATION = 1360.0 (FIG 4, APP F.)

HEIGHT OF DESIGN HEAD ABOVE APRON = 20 FT = $(h_d + d)$ (SHEET 5)

$$\frac{h_d + d}{H_o} = \frac{20}{6.0} = 3.33 \Rightarrow$$ CORRECTION FOR APRON EFFECTS = 1.0 (REF 4, pg 381)

DISCHARGE COEFFICIENT (C) = 3.85 (APRON EFFECT NEGLIGIBLE)

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR
BY WJV DATE 1/23/79 PROJ. NO. 79-617-422
CHKD. BY DLB DATE 1/24/79 SHEET NO. 8 OF 22

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CHECK THE POSSIBILITY OF SUBMERGENCE OF THE WEIR:

CALCULATE THE TAILWATER DEPTH ON THE SPILLWAY APRON BY EQUATING THE SPECIFIC ENERGY AT A POINT JUST UPSTREAM OF THE SPILLWAY CREST TO THE SPECIFIC ENERGY ON THE APRON.

S.E.: SPECIFIC ENERGY = $Y + \frac{v^2}{2g}$ = DISTANCE FROM CHANNEL BED TO ENERGY GRADE LINE ELEVATION (REF 13, PG [illegible])

S.E. @ POINT JUST US OF CREST = $P + H_0$ = 4 + 6 = 10 FT (SHEET 5, [illegible])

S.E. ON APRON = $Y + \frac{v^2}{2g} = Y + \left[Q^2/2g\,A^2\right]$ (SINCE $Q = A v$) (REF [illegible])

APRON WIDTH = 30 FT ⇒ $A = 30Y$ (RECTANGULAR SECTION)
(APPENDIX F, FIG. 4)

ESTIMATED Q = $C_0 L H_0^{3/2} = (3.85)(30\,FT)(5.9\,FT)^{3/2}$
Q = 1655, SAY 1660 CFS

∴ $10\,FT = Y + \left[(1660)^2/2g\,(30Y)^2\right] \Rightarrow Y \cong 4.5\,FT$

$h_d + d$ = 6.0 FT (SHEET 7), $d = Y$ = 4.5 FT ⇒ h_d = 10.5 FT

∴ $h_d/H_0 = 10.5/6.0 \cong 1.8$ ⇒ CORRECTION FOR SUBMERGENCE = 1.0 (REF 4, PG 382)

DISCHARGE COEFFICIENT (C) = 3.85 (SUBMERGENCE EFFECT NEGLIGIBLE)

∴ SPILLWAY CAPACITY ≅ 1660 CFS (AS COMPUTED ABOVE)

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 1/23/79 PROJ. NO. 78-617-423
CHKD. BY DLB DATE 1/24/79 SHEET NO. 9 OF 22

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SPILLWAY RATING CURVE

DISCHARGES DEFINED BY $Q = C L H_e^{3/2}$

DESIGN CRITERIA : H_0 = DESIGN HEAD = 6.0 FT
C_0 = 3.95 @ DESIGN HEAD (CORRECTED FOR COEF SLOPE)
L = SPILLWAY LENGTH = 30 FT
H_e = HEAD ON CREST (OTHER THAN DESIGN)

SEE SHEET 10 FOR COMPUTATIONS.

DAM EMBANKMENT RATING CURVE

ASSUME EMBANKMENT ACTS LIKE A BROAD CRESTED WEIR
WHEN OVERTOPPED: CREST LENGTH (w/o SPILLWAY) = 340 FT (APPEN F, FIG 2)
CREST BREADTH = 20 FT = ℓ,
CREST ELEVATION = 1380.0 FT, AND

$$Q = CLH^{3/2}$$

ELEVATION (FT)	H (FT)	H/ℓ (FT/FT)	*C	Q (CFS)
1380.0	0	—	—	0
1381.0	1	0.05	3.03	1030
1382.0	2	0.10	3.04	2920
1383.0	3	0.15	3.05	5390
1384.0	4	0.20	3.07	8350

* VALUES OF C OBTAINED FROM REF 12, PG 43.

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H_e (FT)	H_e/H_o	A. C_i/C_o	C_i	Estimated Flow per Foot of Weir Length $q=C_iH_e^{3/2}$ (CFS/FT)	Depth of Approach Channel H_e+P (FT)	B. Estimated Approach Velocity v_a (FPS)	C. Entrance Loss H_A (FT)	D. Friction Slope S (FT/FT)	E. Total Approach Loss H_L (FT)	F. Effective Head H (FT)	G. h_d+d (FT)	$\frac{h_d+d}{H_e}$ (FT)	H. h_d/H_e	I. C_s/C_i	C_s	Discharge $Q=C_sLH^{3/2}$
0**	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
1	0.17	0.85	3.27	3.3	5.0	0.7	0.001	0.00004	0.002	1.0	15	15.0	10.0	1.0	3.27	100
2	0.33	0.89	3.43	9.7	6.0	1.6	0.004	0.00018	0.008	2.0	16	8.0	5.0	1.0	3.43	290
3	0.50	0.92	3.54	18.4	7.0	2.6	0.010	0.00041	0.018	3.0	17	5.7	3.4	1.0	3.54	550
4	0.67	0.95	3.66	29.3	8.0	3.7	0.021	0.00074	0.036	4.0	18	4.5	2.6	1.0	3.66	880
5	0.83	0.98	3.77	42.1	9.0	4.7	0.034	0.00108	0.056	4.9	19	3.8	2.1	1.0	3.77	1230
6	1.00	1.00	3.85	56.6	10.0	5.7	0.050	0.00146	0.079	5.9	20	3.3	1.8	1.0	3.85	1660
7	1.17	1.02	3.93	72.8	11.0	6.6	0.068	0.00182	0.104	6.9	21	3.0	1.5	1.0	3.93	2140
8	1.33	1.04	4.00	90.5	12.0	7.5	0.087	0.00220	0.131	7.9	22	2.8	1.4	1.0	4.00	2660
9	1.50	1.06	4.08	110.2	13.0	8.5	0.112	0.00266	0.165	8.8	23	2.6	1.3	1.0	4.08	3200
10	1.67	1.08	4.14*	130.9	14.0	9.4	0.137	0.00309	0.199	9.8	24	2.4	1.2	1.0	4.14	3810

A. C_i/C_o = CORRECTION TO $C_o = 3.85$ FOR HEADS OTHER THAN DESIGN (= 6.0 FT) : FIG. 250, REF 4.

B. $v_a = q/(H_e+P)$

C. $H_A = 0.1 \times$ (APPROACH VELOCITY HEAD $= h_a = \frac{v_a^2}{2g}$) (REF. 4, PG 379)

D. $S = \left(v_a\, n / 1.49\, R^{2/3}\right)^2$ WHERE $n = 0.033$, $R = \frac{30 \times (H_e+P)}{30 + 2(H_e+P)}$ (SHEET 7)

E. $H_L = H_A + (20 \times S)$ SINCE APPROACH CHANNEL = 20 FT IN LENGTH (SHEET 6)

F. $H = H_e - H_L$

G. $h_d + d$ = DISTANCE OF SPILLWAY ENERGY LINE ABOVE THE SPILLWAY APRON (@ ELEV 1360.0)

H. h_d COMPUTED VIA PROCEDURE OUTLINED ON SHEET 8 W/ $H_o = H_e$, AND $C_o = C_i$

I. C_s/C_i = CORRECTION TO C_i FOR EITHER SPILLWAY APRON EFFECTS OR SUBMERGENCE : FIGS 253 AND 254, REF 4.

* $C_i = 4.14$ IS THE UPPER LIMIT FOR OGEE CRESTS (REF 13, PG 25F)

** $H_e = 0 \Rightarrow$ RESERVOIR ELEVATION 1374.0 FT (MSL)

SUBJECT DAM SAFETY INSPECTION
MIDDLE CREEK RESERVOIR

BY WJV DATE 1/24/79 PROJ. NO. 79-617-4[illegible]

CHKD. BY DLB DATE 1/26/79 SHEET NO. 11 OF 22

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TOTAL DISCHARGE RATING CURVE

COMBINED RATING CURVES FOR BOTH THE SPILLWAY AND EMBANKMENT.

ELEVATION (FT)	DISCHARGE (CFS)
1374.0	0
1375.0	100
1376.0	290
1377.0	550
1378.0	880
1379.0	1230
1380.0	1660
1381.0	3170
1382.0	5580
1383.0	8590
1384.0	12160

SUBJECT	DAM SAFETY INSPECTION				
	MOOSE CREEK RESERVOIR				
BY	WJV	DATE	1/19/79	PROJ. NO.	79-617-423
CHKD. BY	DLB	DATE	1/23/79	SHEET NO.	12 OF 22

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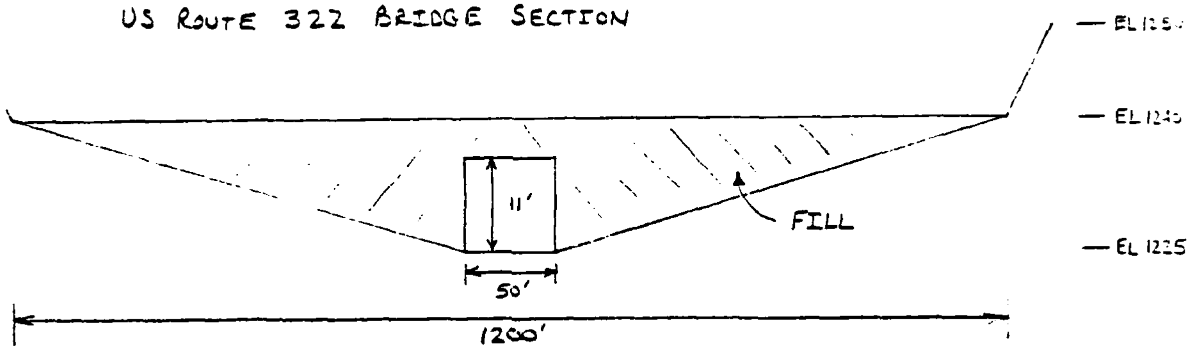
PERFORMANCE CURVE FOR DS HIGHWAY EMBANKMENT

- APPROXIMATE SECTION DIMENSIONS :
  US ROUTE 322 BRIDGE SECTION



- APPROXIMATE CULVERT SLOPE = 1 FT/120 FT ≅ 0.008 FT/FT

- CULVERT DISCHARGES ARE CONTROLLED BY EITHER THE INLET OR THE OUTLET OF THE CULVERT, DEPENDING ON SUCH FACTORS AS CROSS SECTIONAL AREA, LENGTH, ROUGHNESS, SLOPE, AND ENTRANCE CONDITIONS OF THE CULVERT, AS WELL AS HEADWATER AND TAILWATER LEVELS.

-* INLET CONTROL DISCHARGES ARE INDEPENDENT OF TAILWATER DEPTH, AND ARE CONTROLLED BY HEADWATER LEVEL AND ENTRANCE GEOMETRY. FOR H/D (HEADWATER DEPTH TO CULVERT DEPTH RATIO) < 1.2, THE DISCHARGE EQUATION IS :

$$Q = \frac{2}{3} C_B B H \sqrt{\frac{2}{3} g H} \qquad \text{(CONSTRICTED FLOW}$$

* INFORMATION OBTAINED FROM : OPEN CHANNEL FLOW BY F.M. HENDERSON, MACMILLAN PUBLISHING CO., INC., NEW YORK, NEW YORK. 1966 (PG. 263)

SUBJECT DAM SAFETY INSPECTION
MOUSE CREEK RESERVOIR

BY WJV DATE 1/19/79 PROJ. NO. 78-617-423

CHKD. BY DLB DATE 1/23/79 SHEET NO. 13 OF 22

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WHERE Q = DISCHARGE IN CFS, C_B = END CONTRACTION COEFFICIENT = 0.9 (SQUARE EDGED ENTRANCE), B = WIDTH OF CULVERT = 50 FT, H = HEADWATER DEPTH ABOVE INLET INVERT ELEVATION OF 1225 FT, AND g = 32.2 FT/SEC^2.

FOR $H/D > 1.2$:

$$Q = C_h B D \sqrt{2g(H - C_h D)} \qquad \text{(SLUICE FLOW)}$$

WHERE Q, B, g, AND H ARE AS BEFORE, D = DEPTH OF CULVERT = 11 FT, AND C_h = CONTRACTION COEFFICIENT = 0.6 (SQUARE EDGED ENTRANCE).

- **OUTLET CONTROL DISCHARGES ARE ESPECIALLY DEPENDENT ON TAILWATER LEVEL, ALONG WITH ALL OTHER CHARACTERISTICS OF THE CULVERT BARREL. OUTLET CONTROL CAN OCCUR IF $H > 0.75D$, WITH DISCHARGE DEFINED BY ITS RELATIONSHIP TO HW IN THE EQUATION BELOW.

$$HW = \left[1 + k_e + \frac{29 n^2 L}{R^{1.33}}\right] \frac{Q^2}{2gA^2} + TW - L_{S_0}$$

WHERE: HW = WATER SURFACE ELEVATION @ INLET IN FT; K_e = ENTRANCE LOSS COEFFICIENT $\approx$ 0.4 (WINGWALLS @ 30° TO CULVERT); $n \approx 0.030$; $A = 550$ FT^2; $R = \frac{550 FT^2}{122 FT} \approx 4.5$; L = LENGTH OF CULVERT $\approx$ 130 FT (FIELD MEASURED); Q = CULVERT DISCHARGE IN CFS;

** INFORMATION OBTAINED FROM: "HYDRAULIC CHARTS FOR THE SELECTION OF HIGHWAY CULVERTS", HEC NO. 5, BUREAU OF PUBLIC ROADS.

SUBJECT DAM SAFETY INSPECTION
MUD CREEK RESERVOIR

BY WJV DATE 1/19/79 PROJ. NO. 79-617-432
CHKD. BY DLB DATE 1/23/79 SHEET NO. 14 OF 22

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TW = TAILWATER ELEVATION =
ELEVATION OF OUTLET INVERT (1234.0 FT) + THE AVERAGE OF THE APPROPRIATE CRITICAL DEPTH AND THE DEPTH OF THE CULVERT $\left(\frac{d_c+D}{2}\right)$, OR THE DEPTH OF THE CULVERT (WHICHEVER IS SMALLER) UP TO HW = 1240 FT AT WHICH POINT WEIR FLOW BEGINS WHICH SHOULD DROWN OUT THE OUTLET.
∴ ABOVE HW = 1240, TW IS ASSUMED TO = 1237.5 (MIDWAY BETWEEN TOP OF CULVERT AND TOP OF ROAD).

- ALSO, ABOVE ELEVATION 1240.0, WEIR FLOW WILL BE POSSIBLE, AND IS DEFINED BY:

$$Q = CLH_0^{3/2}$$

WHERE Q = DISCHARGE IN CFS; L = LENGTH OF WEIR ≈ 1200 FT; AND H_0 = DEPTH OF WATER ABOVE WEIR CREST OF 1240.0 FT; AND C = VARIES WITH H_0 ACCORDING TO REF 12 AND CREST BREADTH ≈ 85 FT.

- FLOW COMPUTATIONS:

	ELEVATION (FT)	H_0 (FT)	** C	Q (CFS)
	1240	0	—	0
WEIR FLOW	1241	1	3.03	3640
	1242	2	3.04	10320
	1243	3	3.05	19020
	1244	4	3.05	29280

** ESTIMATED "C" VALUES FROM REF 12

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 1/22/79 PROJ. NO. 79-617-423

CHKD. BY DLB DATE 1/23/79 SHEET NO. 15 OF 22

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INLET CONTROL FLOWS

ELEVATION (FT)	H (FT)	H/D (FT/FT)	Q (CFS)
1225	0	–	0
1226	1	0.1	140
1227	2	0.2	340
1228	3	0.3	720
1229	4	0.4	1110
1230	5	0.45	1550
1231	6	0.5	2040
1232	7	0.6	2570
1233	8	0.7	3150
1234	9	0.8	3750
1235	10	0.9	4400
1236	11	1.0	5070
1237	12	1.1	5780
1238	13	1.2	6520
1239	14	1.3	7200
1240	15	1.4	7680
1241	16	1.45	8120
1242	17	1.5	8540
1243	18	1.6	8940
1244	19	1.7	93[illegible]

SUBJECT DAM SAFETY INSPECTION

[illegible] CREEK RESERVOIR

BY WJV DATE 1/22/79 PROJ. NO. 79-617-[illegible]

CHKD. BY DLB DATE 1/23/79 SHEET NO. 16 OF 22

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	Q (CFS)	d_c*** (FT)	***$\frac{d_c+D}{2}$ or D (FT)	TW (FT)	LS_o (FT)	HW (FT)	
	5000	[illegible]	8.9	1232.7	1.0	1234.2	> [illegible] + INVERT ELEV.
	5500	7.2	9.1	1232.1	1.[illegible]	12[illegible]	
	6000	7.6	9.3	12[illegible]	[illegible]	123[illegible]	
OUTLET	6500	8.1	9.6	1233.6	1.0	123[illegible]	
CONTROL	7000	8.5	9.8	1233.8	1.0	1237.5	
FLOW	7500	8.9	10.0	1234.0	1.0	123[illegible].4	
	[illegible]	9.3	10.2	1234.[illegible]	1.0	123[illegible].3	
	8500	9.6	10.3	1234.3	1.0	[illegible]	
	9000	–	–	1237.5	1.[illegible]	1244.2	
	95[illegible]	–	–	1237.5	1.[illegible]	1245.1	
	[illegible]	–	–	1237.5	1.[illegible]	1246.0	
	105[illegible]	–	–	1237.5	1.[illegible]	1247.0	

*** d_c = CRITICAL DEPTH = $\sqrt[3]{q^2/g}$ WHERE q = Q/[illegible]

D = DEPTH OF CULVERT = 11 FT

– TOTAL FLOW ABOVE ELEVATION 1240.0 :

ELEVATION (FT)	Q_{WEIR} (CFS)	Q_{INLET} (CFS)	Q_{WEIR} + Q_{INLET} (CFS)	**** Q_{OUTLET} (CFS)	Q_{WEIR} + Q_{OUTLET} (CFS)
1240	0	7690	7690	8390	8390
1241	3640	8120	11760	8600	12240
1242	10320	8540	18860	8730	1905[illegible]
1243	19020	8940	27960	885[illegible]	27870
1244	29280	9330	38610	8980	38260

**** OUTLET CONTROL FLOWS ARE INTERPOLATED FROM OUTLET CONTROL FLOW TABLE ABOVE

SUBJECT	DAM SAFETY INSPECTION MOOSE CREEK RESERVOIR		
BY	WJV	DATE	1/22/79
PROJ. NO.	73-617-42?		
CHKD. BY	DLB	DATE	1/23/79
SHEET NO.	17	OF	22

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- FROM INTERPOLATION WITHIN AND AMONG THE VARIOUS TABLES, THE PERFORMANCE CURVE FOR THIS CULVERT (AND EMBANKMENT) WILL CONSIST OF INLET CONTROL UNTIL THE HEADWATERS REACH ABOUT ELEVATION 1242.7 FT. ABOVE THIS ELEVATION, OUTLET CONTROL WILL DOMINATE. WEIR FLOW ABOVE ELEVATION 1240.0 WILL OCCUR IN COMBINATION WITH BOTH THE INLET AND OUTLET CONTROL FLOWS

- PERFORMANCE CURVE FOR DS EMBANKMENT (IN TABULAR FORM):

ELEVATION (FT)	Q (CFS)
1225	0
1227	390
1229	1110
1231	2040
1233	3150
1235	4400
1237	5790
1239	7200
1240	7690
1241	11760
1242	18860
*1242.7	25230
1243	27870
1244	38260

* TRANSITION BETWEEN INLET AND OUTLET CONTROL

SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY WJV DATE 1/22/79 PROJ. NO. 79-417-422

CHKD. BY DLB DATE 1/23/79 SHEET NO. 18 OF 22

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ELEVATION - STORAGE RELATIONSHIP FOR DS EMBANKMENT

SA @ ELEVATION 1240 $\sim (0.06\ \text{in}^2) \times \left(\frac{4000000\ \text{ft}^2/\text{in}^2}{43560\ \text{ft}^2/\text{acre}}\right) = 5.5$ ACRES

SA @ ELEVATION 1260 $\sim (0.17\ \text{in}^2) \times \left(\frac{4000000\ \text{ft}^2/\text{in}^2}{43560\ \text{ft}^2/\text{acre}}\right) = 15.$[illegible] ACRES

SA @ ELEVATION 1225 $\approx$ 0.0 ACRES

∴ TREAT EMBANKMENT LIKE A DAM WITH THE ELEVATION - STORAGE RELATIONSHIP INTERNALLY COMPUTED BY THE HEC-1-DAM PROGRAM BASED ON THE ABOVE INFORMATION.

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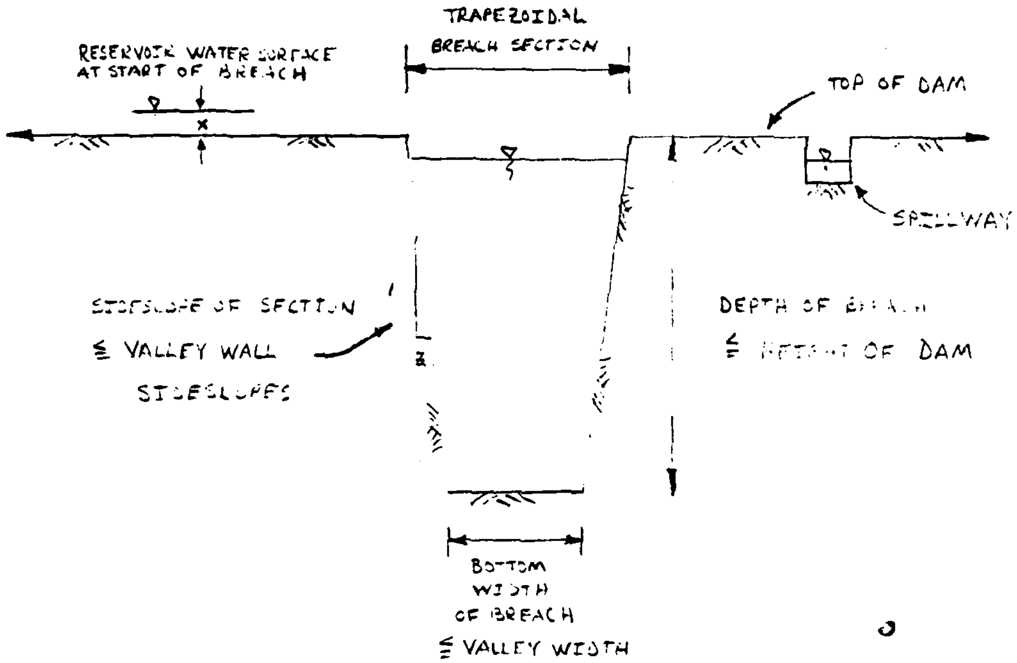
BREACHING ASSUMPTIONS

- TYPICAL BREACH SECTION :



- HEC-1-DAM BREACHING ANALYSIS INPUTS :
(BREACHING BEGINS WHEN RESERVOIR LEVEL REACHES THE TOP OF DAM ELEVATION)

PLAN NUMBER AND COMMENTS	BREACH BOTTOM WIDTH (FT)	BREACH DEPTH (FT)	SECTION SIDESLOPES	BREACH TIME* (HR)	WS HEIGHT ABOVE DAM AT BEGINNING OF BREACH (FT)
MIN BREACH SECT, MIN. FAIL TIME	0	28	½ to 1	0.25	0
MAX. BREACH SECT, MIN. FAIL TIME	250	28	1 to 1	0.25	0
MIN. BREACH SECT, MAX. FAIL TIME	0	28	½ to 1	4.0	0
MAX. BREACH SECT, MAX. FAIL TIME	250	28	1 to 1	4.0	0
AVERAGE POSSIBLE CONDITIONS	100	28	1 to 1	1.0	0

* BREACH TIME = TOTAL TIME NECESSARY TO REACH FINAL BREACH DIMENSIONS

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 1-29-79 PROJ. NO. 78-617-4[illegible]

CHKD. BY DLB DATE 1-29-79 SHEET NO. 20 OF 22

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- THE PREVIOUS ASSUMPTIONS ARE BASED SOMEWHAT ON THE FOLLOWING SUGGESTED RANGES FOR EARTH DAM BREACHING*:

BREACH BOTTOM WIDTH → $\frac{\text{DAM HEIGHT}}{2}$ < WIDTH < 3×(DAM HEIGHT)

SECTION SIDESLOPE → 0 < Z < 1

BREACH TIME → 0.5 < TIME < 4.0

WATER SURFACE HEIGHT ABOVE DAM AT WHICH BREACHING BEGINS → 1 < HEIGHT < 5
(HOWEVER, GAI CONTENDS THAT ANY AMOUNT OF OVERTOPPING COULD CAUSE FAILURE; SEE SECTION 5.5, PG 17 FOR A FURTHER EXPLANATION)

AND ALSO ON THE PHYSICAL CONSTRAINTS OF THE DAM AND SURROUNDING TERRAIN:

	CONSTRAINT	VALUE
	- HEIGHT OF DAM	31 FT
	- HEIGHT OF EMBANKMENT FILL	29 FT
	- LENGTH OF DAM CREST w/o SPILLWAY	340 FT
	- LENGTH OF DAM CREST TO THE LEFT OF THE SW	310 FT
**	- VALLEY BOTTOM WIDTH	250 FT
**	- VALLEY SIDESLOPES: RIGHT WALL	3 to 1
	LEFT WALL	4 to 1
	DESCRIPTION	EARTH DAM w/ CONCRETE CORE WALL, HAND PLACED RIP RAP US, AND BROKEN STONE DS FACE COVERINGS.

* INFORMATION OBTAINED FROM BALTIMORE DISTRICT, CORPS OF ENGINEERS

** ESTIMATED FROM USGS TOPO. MAP AND FIELD OBSERVATION

SUBJECT DAM SAFETY INSPECTION
MODE CREEK [illegible]

BY WJV DATE 2-15-79 PROJ. NO. 78-617-423

CHKD. BY DLB DATE 2-17-79 SHEET NO. 21 OF 22

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HEC-1 - DAM BREACHING ANALYSIS OUTPUT :

RESERVOIR DATA

A. 1/2 PMF RESERVOIR INFLOW CONDITIONS -

PLAN* NUMBER	VARIABLE BREACH BOTTOM WIDTH (FT)	ACTUAL MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF FLOW (HR)	INTERPOLATED OR HEC-1 ROUTED MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF FLOW (HR)	ACTUAL PEAK FLOW THROUGH DAM (CFS)	CORRESPONDING TIME OF PEAK (HR)	TIME OF INITIAL BREACH (HR)
1	0	4679	16.75	4678	16.75	4678	16.75	16.50
2	250	8521	16.59	8478	16.58	8521	16.59	16.50
3	0	4367	20.08	4367	20.08	4367	20.08	16.50
4	250	4258	19.67	4255	19.67	4258	19.67	16.50
5	100	3771	16.94	3751	16.92	4120	19.83	16.50

B. 3/10 PMF RESERVOIR INFLOW CONDITIONS -

PLAN* NUMBER	VARIABLE BREACH BOTTOM WIDTH (FT)	ACTUAL MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF FLOW (HR)	INTERPOLATED OR HEC-1 ROUTED MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF FLOW (HR)	ACTUAL PEAK FLOW THROUGH DAM (CFS)	CORRESPONDING TIME OF PEAK (HR)	TIME OF INITIAL BREACH (HR)
1	0	4516	18.00	4511	18.00	4516	18.00	17.75
2	250	8478	17.84	8442	17.83	8478	17.94	17.75
3	0	2625	20.08	2625	20.08	2625	20.08	17.75
4	250	2776	19.42	2776	19.42	2776	19.41	17.75
5	100	3588	19.19	3582	18.17	3588	18.11	17.75

* SEE TABLE ON SHEET 19

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 2-15-79 PROJ. NO. 79-617-423

CHKD. BY DLB DATE 2-17-79 SHEET NO. 22 OF 22

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HEC-1-DAM BREACHING ANALYSIS OUTPUT:

DOWNSTREAM ROUTING DATA

A. 1/2 PMF DOWNSTREAM BASE CONDITIONS -

PLAN* NUMBER	VARIABLE BREACH BOTTOM WIDTH (FT)	OUTPUT @ X-SECT. LOCATED 4800 FT DS OF DAM: PEAK FLOW (CFS)	TIME OF FLOW (HR)	CORRESPONDING WSEL (FT)	WSEL** W/O BREACH (FT)	***ΔELEV. (FT)	OUTPUT @ X-SECT. LOCATED 6100 FT DS OF DAM: PEAK FLOW (CFS)	TIME OF FLOW (HR)	CORRESPONDING WSEL (FT)	WSEL** W/O BREACH (FT)	***ΔELEV. (FT)
1	0	4108	20.08	1251.0	1251.0	+0.0	4107	20.08	1227.3	1227.3	+0.0
2	250	4826	16.67	1251.5	1251.0	+0.5	4672	16.75	1227.8	1227.3	+0.5
3	0	4355	20.17	1251.2	1251.0	+0.2	4354	20.25	1227.6	1227.3	+0.3
4	250	4251	19.75	1251.1	1251.0	+0.1	4251	19.33	1227.4	1227.3	+0.1
5	100	4112	17.92	1251.0	1251.0	+0.0	4112	20.00	1227.3	1227.3	+0.0

* SEE TABLE ON SHEET 19. ** WSEL W/O BREACH OBTAINED FROM OVERTOPPING ANALYSIS OUTPUT ⇒ WSEL CORRESPONDING TO PEAK FLOW. *** ΔELEV = CORRESPONDING WSEL - WSEL W/O BREACH

B. 3/10 PMF DOWNSTREAM BASE CONDITIONS -

PLAN* NUMBER	VARIABLE BREACH BOTTOM WIDTH (FT)	OUTPUT @ X-SECT. LOCATED 4800 FT DS OF DAM: PEAK FLOW (CFS)	TIME OF FLOW (HR)	CORRESPONDING WSEL (FT)	WSEL** W/O BREACH (FT)	***ΔELEV. (FT)	OUTPUT @ X-SECT. LOCATED 6100 FT DS OF DAM: PEAK FLOW (CFS)	TIME OF FLOW (HR)	CORRESPONDING WSEL (FT)	WSEL** W/O BREACH (FT)	***ΔELEV. (FT)
1	0	3244	18.08	1250.1	1248.9	+1.2	3204	18.17	1226.1	1224.5	+1.6
2	250	4833	17.92	1251.6	1248.9	+2.7	[illegible]	[illegible]	1227.8	1224.5	+3.3
3	0	2619	20.42	1249.3	1248.9	+0.4	[illegible]	[illegible]	1225.4	1224.5	+0.9
4	250	2771	19.58	1249.5	1248.9	+0.6	2771	19.58	1225.5	1224.5	+1.0
5	100	3379	18.33	[illegible]	[illegible]	+1.4	3361	18.33	[illegible]	[illegible]	+1.9

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR
BY JV DATE 2-28-79 PROJ. NO. 79-617-423
CHKD. BY DLB DATE 2-28-79 SHEET NO. A OF

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SUMMARY INPUT/OUTPUT SHEETS

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DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR DAM ******* OVERTOPPING ANALYSIS *******
5-MINUTE TIME STEP AND 24-HOUR STORM DURATION

                              JOB SPECIFICATION
   NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
  288        0        5        0        0        0        0        0        0        0
                           JOPER      NWT    LROPT    TRACE
                               5        0        0        0

                        MULTI-PLAN ANALYSES TO BE PERFORMED
                          NPLAN= 1 NRTIO= 3 LRTIO= 1
     RTIOS=     .20     .50    1.00

**********         **********         **********         **********         **********

                           SUB-AREA RUNOFF COMPUTATION

   INFLOW TO RESERVOIR

               ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                   1        0        0        0        0        0        1        0        0

                              HYDROGRAPH DATA
   IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
       1        1     6.40     0.00     6.40     0.00    0.000        0        1        0

                                PRECIP DATA
            SPFE      PMS       R6      R12      R24      R48      R72      R96
            0.00    22.90   117.50   127.00   136.00     0.00     0.00     0.00
TRSPC COMPUTED BY THE PROGRAM IS   .800
                                                    INITIAL AND CONSTANT RAINFALL
                                                      LOSSES, RESPECTIVELY (AS PER COE)
                                LOSS DATA
   LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
       0     0.00     0.00     1.00     0.00     0.00     1.00     1.00      .05     0.00     0.00

                              UNIT HYDROGRAPH DATA
                          TP=  4.31     CP= .45     NTA=  0

BASE FLOW PARAMETERS
 (AS PER COE)                    RECESSION DATA
                 STRTQ=    -1.50     QRCSN=     -.05     RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=52.63 AND R=81.39 INTERVALS

     UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=   4.34 HOURS, CP=  .45  VOL=  .59
      1.       1.       9.      15.      21.      28.      36.      45.      54.      63.
     73.      83.      94.     105.     116.     128.     140.     152.     164.     177.
    190.     203.     216.     229.     243.     257.     271.     285.     298.     311.
    323.     334.     346.     356.     366.     376.     385.     394.     402.     409.
    416.     423.     428.     434.     438.     442.     445.     448.     450.     450.
    450.     449.     446.     441.     436.     430.     425.     420.     415.     410.
    405.     400.     395.     390.     385.     381.     376.     371.     367.     362.
    358.     354.     349.     345.     341.     337.     332.     328.     324.     320.
    317.     313.     309.     305.     301.     298.     294.     290.     287.     283.
    280.     277.     273.     270.     267.     263.     260.     257.     254.     251.
```

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY JV DATE 2-28-79 PROJ. NO. 78-617-423

CHKD. BY DLB DATE 2-28-79 SHEET NO. B OF

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0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.92	23.07	1.84	638344.
										(633.)(	586.)(	47.)(	18075.89)

RESERVOIR INFLOW HYDROGRAPHS

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8239.	6798.	2213.	2213.	637228.
CMS	233.	193.	63.	63.	18044.
INCHES		9.88	12.86	12.86	12.86
MM		250.99	326.74	326.74	326.74
AC-FT		3371.	4389.	4389.	4389.
THOUS CU M		4158.	5413.	5413.	5413.

0.2 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1648.	1360.	443.	443.	127446.
CMS	47.	39.	13.	13.	3609.
INCHES		1.98	2.57	2.57	2.57
MM		50.20	65.35	65.35	65.35
AC-FT		674.	878.	878.	878.
THOUS CU M		832.	1083.	1083.	1083.

0.5 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4120.	3399.	1106.	1106.	318614.
CMS	117.	96.	31.	31.	9022.
INCHES		4.94	6.43	6.43	6.43
MM		125.49	163.37	163.37	163.37
AC-FT		1686.	2194.	2194.	2194.
THOUS CU M		2079.	2707.	2707.	2707.

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1374.	-1

STAGE 1374.00 1375.00 1376.00 1377.00 1378.00 1379.00 1380.00 1381.00 1382.00
1384.00

FLOW 0.00 100.00 290.00 550.00 880.00 1230.00 1660.00 3170.00 5580.00
12160.00

SURFACE AREA= 0. 5. 7. 14.

CAPACITY= 0. 52. 87. 290.

ELEVATION= 1342. 1374. 1380. 1400.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
1374.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 2-28-79 PROJ. NO. 79-617-423

CHKD. BY DLB DATE 2-28-79 SHEET NO. C OF

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DAM DATA

TOPEL	COQD	EXPD	DAMWID
1380.0	0.0	0.0	0.

RESERVOIR OUTFLOW HYDROGRAPH

PMF

PEAK OUTFLOW IS 8240. AT TIME 19.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8240.	6796.	2193.	2193.	631606.
CMS	233.	192.	62.	62.	17885.
INCHES		9.88	12.75	12.75	12.75
MM		250.97	323.86	323.86	323.86
AC-FT		3371.	4350.	4350.	4350.
THOUS CU M		4158.	5366.	5366.	5366.

0.2PMF

PEAK OUTFLOW IS 1642. AT TIME 20.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1642.	1357.	434.	434.	124947.
CMS	46.	38.	12.	12.	3538.
INCHES		1.97	2.52	2.52	2.52
MM		50.10	64.07	64.07	64.07
AC-FT		673.	861.	861.	861.
THOUS CU M		830.	1061.	1061.	1061.

0.5PMF

PEAK OUTFLOW IS 4120. AT TIME 19.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4120.	3399.	1090.	1090.	314052.
CMS	117.	96.	31.	31.	8893.
INCHES		4.94	6.34	6.34	6.34
MM		125.47	161.03	161.03	161.03
AC-FT		1685.	2163.	2163.	2163.
THOUS CU M		2079.	2668.	2668.	2668.

HYDROGRAPH ROUTING

ROUTE FROM RESERVOIR TO SECTION 2 + 4800 FT DOWNSTREAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
102	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY NJV DATE 2-29-79 PROJ. NO. 79-617-423

CHKD. BY DLB DATE 2-28-79 SHEET NO. D OF

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NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0500	.1000	1240.0	1280.0	4800.	.02300

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1280.00 100.00 1260.00 200.00 1244.00 202.00 1240.00 213.00 1240.00
215.00 1246.00 400.00 1260.00 700.00 1280.00

STORAGE	0.00	2.76	5.93	11.26	23.82	45.88	77.45	118.53	169.11
	298.83	378.19	467.32	566.22	674.89	793.32	921.52	1059.49	1207.23
OUTFLOW	0.00	154.95	470.18	988.68	1936.74	3577.98	6147.55	9847.75	14862.00
	29495.77	39434.31	51338.75	65353.75	81619.53	100272.23	121444.29	145264.78	171859.72
STAGE	1240.00	1242.11	1244.21	1246.32	1248.42	1250.53	1252.63	1254.74	1256.84
	1261.05	1263.16	1265.26	1267.37	1269.47	1271.58	1273.68	1275.79	1277.89
FLOW	0.00	154.95	470.18	988.68	1936.74	3577.98	6147.55	9847.75	14862.00
	29495.77	39434.31	51338.75	65353.75	81619.53	100272.23	121444.29	145264.78	171859.72

DOWNSTREAM ROUTING SECTION (@ FIRST HOUSE) OUTFLOW

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8226.	6792.	2173.	2173.	625940.
CMS	233.	192.	62.	62.	17725.
INCHES		9.87	12.64	12.64	12.64
MM		250.75	320.96	320.96	320.96
AC-FT		3368.	4311.	4311.	4311.
THOUS CU M		4154.	5317.	5317.	5317.

PMF

MAXIMUM STORAGE = 101.

MAXIMUM STAGE IS 1253.8

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 2-28-79 PROJ. NO. 79-617-423
CHKD. BY DLB DATE 2-28-79 SHEET NO. E OF

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HYDROGRAPH ROUTING

ROUTE FROM SECTION 2 THROUGH THE DS HWY EMBANKMENT :SEC 3 + ROUFT DS OF SEC 2

```
ISTAQ  ICOMP  IECON  ITAPE  JPLT  JPRT  INAME  ISTAGE  IAUTO
  203      1      0      0     0     0      1       0      0
                    ROUTING DATA
QLOSS  CLOSS    AVG   IRES  ISAME  IOPT  IPMP          LSTR
  0.0  0.000   0.00      1      1     0     0             0

        NSTPS  NSTDL    LAG  AMSKK      X    TSK  STORA  ISPRAT
            1      0      0  0.000  0.000  0.000    -1.     -1
```

```
STAGE     1225.00   1227.00   1229.00   1231.00   1233.00   1235.00   1237.00   1239.00   1240.00
          1242.00   1242.70   1243.00   1244.00

FLOW         0.00    390.00   1110.00   2040.00   3150.00   4400.00   5780.00   7200.00   7680.00
         16600.00  25230.00  27870.00  38260.00

SURFACE AREA=      0.        0.       16.
    CAPACITY =     0.       28.      230.
  ELEVATION=    1225.     1240.     1260.

        CREL   SPWID   COQW   EXPW   ELEVL   COQL   CAREA   EXPL
      1240.0     0.0    0.0    0.0     0.0    0.0     0.0    0.0

                          DAM DATA
                TOPEL   COQD   EXPD   DAMWID
               1240.0    0.0    0.0       0.
```

PEAK OUTFLOW IS 8226. AT TIME 20.00 HOURS

PMF

US ROUTE 322
EMBANKMENT
"DAM"
OUTFLOW

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8226.	6791.	2171.	2171.	625319.
CMS	233.	192.	61.	61.	17707.
INCHES		9.87	12.62	12.62	12.62
MM		250.72	320.64	320.64	320.64
AC-FT		3360.	4307.	4307.	4307.
THOUS CU M		4154.	5312.	5312.	5312.

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 2-28-79 PROJ. NO. 78-617-423

CHKD. BY DLB DATE 2-25-79 SHEET NO. F OF

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HYDROGRAPH ROUTING

ROUTE FROM HIGHWAY EMBANKMENT TO SECTION 4 * 500 FT DOWNSTREAM OF EMBANKMENT

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
304	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

ORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.1000	.0400	.1000	1216.0	1260.0	500.	.01600

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1260.00 25.00 1240.00 400.00 1224.00 401.00 1216.00 419.00 1216.00
420.00 1224.00 650.00 1240.00 750.00 1260.00

STORAGE	0.00	.49	.99	1.50	2.38	5.35	10.64	18.26	28.21
	55.09	71.62	88.67	106.11	123.93	142.13	160.72	179.70	199.06
OUTFLOW	0.00	302.75	870.87	1581.20	2546.99	4360.66	7590.93	12725.69	20189.39
	43619.58	62074.01	84851.05	110734.41	139610.71	171396.21	206027.77	243457.19	283647.60
STAGE	1216.00	1218.32	1220.63	1222.95	1225.26	1227.58	1229.89	1232.21	1234.53
	1239.16	1241.47	1243.79	1246.11	1248.42	1250.74	1253.05	1255.37	1257.68
FLOW	0.00	302.75	870.87	1581.20	2546.99	4360.66	7590.93	12725.69	20189.39
	43619.58	62074.01	84851.05	110734.41	139610.71	171396.21	206027.77	243457.19	283647.60

DOWNSTREAM ROUTING SECTION (WITHIN MAJOR DAMAGE CENTER) OUTFLOWS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8226.	6791.	2169.	2169.	624804.
CMS	233.	192.	61.	61.	17692.
INCHES		9.87	12.61	12.61	12.61
MM		250.73	320.37	320.37	320.37
AC-FT		3368.	4303.	4303.	4303.
THOUS CU M		4154.	5308.	5308.	5308.

PMF

MAXIMUM STORAGE = 12.

MAXIMUM STAGE IS 1230.2

SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY NJV DATE 2-28-79 PROJ. NO. 79-617-423

CHKD. BY DLB DATE 2-28-79 SHEET NO. G OF

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SUMMARY OF DAM SAFETY ANALYSIS

MOOSE CREEK RESERVOIR DAM

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1374.00	1374.00	1380.00
STORAGE	52.	52.	87.
OUTFLOW	0.	0.	1660.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1379.96	0.00	87.	1642.	0.00	20.00	0.00
.50	1381.39	1.39	97.	4120.	7.33	19.83	0.00
1.00	1382.88	2.88	108.	8240.	8.83	19.83	0.00
* 0.30	1380.5	0.5		2470.			

VERTOPPING OCCURS @ ≈ 0.2PMF

PLAN 1 STATION 102

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	1639.	1247.8	20.17
.50	4112.	1251.0	20.00
1.00	8226.	1253.8	19.92
* 0.30	2470.	1248.9	

1st FLOOR ELEVATION OF HOUSE LOCATED @ THIS SECTION ≈ 1248 FT

US ROUTE 322 EMBANKMENT "DAM"

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1225.00	1240.00	1240.00
STORAGE	0.	28.	28.
OUTFLOW	0.	7680.	7680.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1230.14	0.00	1.	1639.	0.00	20.17	0.00
.50	1234.54	0.00	7.	4111.	0.00	20.00	0.00
1.00	1240.13	.13	28.	8226.	1.75	20.00	0.00
* 0.30	1231.6	0.00		2470.			

PLAN 1 STATION 304

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	1639.	1223.1	20.17
.50	4111.	1227.3	20.00
1.00	8226.	1230.2	20.00
* 0.30	2470.	1224.5	

1st FLOOR ELEVATION OF BUILDINGS LOCATED @ THIS SECTION ≈ 1225

* INTERPOLATED VALUES

SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY NJV DATE 2-28-79 PROJ. NO. 78-617-423
CHKD. BY DLB DATE 2-28-79 SHEET NO. H OF

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DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR DAM ******** BREACHING  ANALYSIS *******
5-MINUTE TIME STEP AND 24-HOUR STORM DURATION

                          JOB SPECIFICATION
  NO     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
 288       0       5       0       0       0       0       0      -4       0
                       JOPER     NWT   LROPT   TRACE
                           5       0       0       0

                 MULTI-PLAN ANALYSES TO BE PERFORMED
                    NPLAN= 5 NRTIO= 1 LRTIO= 1
  RTIOS=     .50

                    ROUTE THROUGH RESERVOIR
                                           DAM DATA
                                   TOPEL     COQD     EXPD   DAMWID
                                  1380.0      0.0      0.0       0.

                                       DAM BREACH DATA
                             BRWID       Z    ELBM    TFAIL     WSEL   FAILEL
                                0.     .50 1352.00      .25  1374.00  1380.00
```

PLAN

```
(1)  BEGIN DAM FAILURE AT 16.50 HOURS

     PEAK OUTFLOW IS     4678. AT TIME  16.75 HOURS
                                       DAM BREACH DATA
                             BRWID       Z    ELBM    TFAIL     WSEL   FAILEL
                              250.    1.00 1352.00      .25  1374.00  1380.00

(2)  BEGIN DAM FAILURE AT 16.50 HOURS

     PEAK OUTFLOW IS     8521. AT TIME  16.59 HOURS
                                       DAM BREACH DATA
                             BRWID       Z    ELBM    TFAIL     WSEL   FAILEL
                                0.     .50 1352.00     4.00  1374.00  1380.00

(3)  BEGIN DAM FAILURE AT 16.50 HOURS

     PEAK OUTFLOW IS     4367. AT TIME  20.08 HOURS
                                       DAM BREACH DATA
                             BRWID       Z    ELBM    TFAIL     WSEL   FAILEL
                              250.    1.00 1352.00     4.00  1374.00  1380.00

(4)  BEGIN DAM FAILURE AT 16.50 HOURS

     PEAK OUTFLOW IS     4258. AT TIME  19.67 HOURS
                                       DAM BREACH DATA
                             BRWID       Z    ELBM    TFAIL     WSEL   FAILEL
                              100.    1.00 1352.00     1.00  1374.00  1380.00

(5)  BEGIN DAM FAILURE AT 16.50 HOURS

     [illegible]
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SUBJECT DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY WJV DATE 2-28-79 PROJ. NO. 78-617-423

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .083 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS) -	COMPUTED BREACH HYDROGRAPH (CFS) =	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
16.500	0.000	1677.	1677.	0.	0.	0.
16.521	.021	1895.	1855.	40.	40.	0.
16.542	.042	2112.	2065.	47.	87.	0.
16.563	.063	2330.	2310.	20.	107.	0.
16.583	.083	2547.	2547.	-0.	107.	0.
16.604	.104	2712.	2757.	-45.	62.	0.
16.625	.125	2876.	2934.	-57.	5.	0.
16.646	.146	3040.	3077.	-37.	-32.	-0.
16.667	.167	3205.	3205.	0.	-32.	-0.
16.688	.188	3278.	3311.	-33.	-65.	-0.
16.708	.208	3351.	3390.	-40.	-105.	-0.
16.729	.229	3424.	3452.	-29.	-134.	-0.
16.750	.250	3497.	3497.	0.	-134.	-0.
16.771	.271	3531.	3532.	-2.	-135.	-0.
16.792	.292	3564.	3572.	-8.	-143.	-0.
16.813	.313	3598.	3595.	3.	-140.	-0.
16.833	.333	3631.	3631.	0.	-140.	-0.
16.854	.354	3661.	3649.	12.	-128.	-0.
16.875	.375	3691.	3686.	4.	-124.	-0.
16.896	.396	3721.	3706.	15.	-109.	-0.
16.917	.417	3751.	3751.	0.	-109.	-0.
16.938	.437	3746.	3771.	-25.	-134.	-0.
16.958	.458	3742.	3771.	-29.	-163.	-0.
16.979	.479	3738.	3758.	-19.	-182.	-0.
17.000	.500	3734.	3734.	0.	-182.	-0.
17.021	.521	3700.	3704.	-4.	-186.	-0.
17.042	.542	3666.	3671.	-4.	-191.	-0.
17.063	.562	3632.	3635.	-3.	-193.	-0.
17.083	.583	3598.	3598.	0.	-193.	-0.
17.104	.604	3563.	3562.	1.	-192.	-0.
17.125	.625	3528.	3526.	2.	-190.	-0.
17.146	.646	3492.	3491.	2.	-188.	-0.
17.167	.667	3457.	3457.	0.	-188.	-0.
17.188	.687	3427.	3425.	2.	-186.	-0.
17.208	.708	3398.	3394.	3.	-183.	-0.
17.229	.729	3368.	3365.	2.	-181.	-0.
17.250	.750	3338.	3338.	0.	-181.	-0.
17.271	.771	3314.	3312.	2.	-178.	-0.
17.292	.792	3291.	3288.	3.	-175.	-0.
17.313	.812	3267.	3265.	2.	-173.	-0.
17.333	.833	3243.	3243.	0.	-173.	-0.
17.354	.854	3226.	3224.	2.	-171.	-0.
17.375	.875	3208.	3205.	3.	-168.	-0.
17.396	.896	3191.	3189.	2.	-166.	-0.
17.417	.917	3173.	3173.	0.	-166.	-0.
17.438	.937	3161.	3159.	2.	-163.	-0.
17.458	.958	3149.	3147.	3.	-161.	-0.
17.479	.979	3138.	3136.	2.	-159.	-0.

5

SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY WJV DATE 2-28-79 PROJ. NO. 78-617-423

CHKD. BY DLB DATE 2-28-79 SHEET NO. J OF

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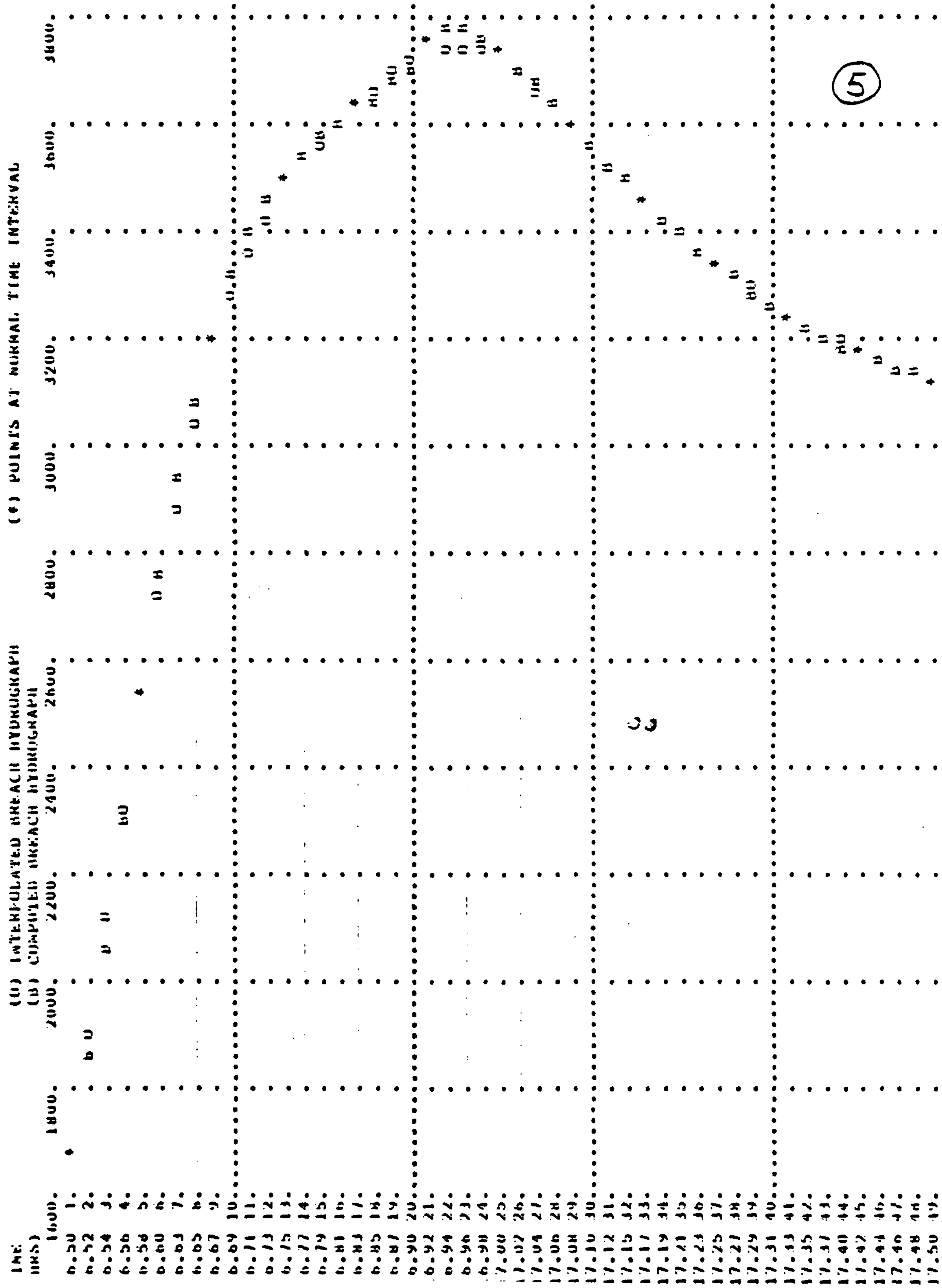
(5)



SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY NJV DATE 2-28-79 PROJ. NO. 79-617-423

CHKD. BY DLB DATE 2-28-79 SHEET NO. K OF

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```
DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR DAM ******** BREACHING  ANALYSIS *******
5-MINUTE TIME STEP AND 24-HOUR STORM DURATION

                         JOB SPECIFICATION
 NQ      NHR      NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
288        0         5        0        0        0        0        0       -4        0
                          JOPER      NWT    LROPT    TRACE
                              5        0        0        0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                       NPLAN= 5 NRTIO= 1 LRTIO= 1
    RTIOS=    .30

                          ROUTE THROUGH RESERVOIR

                                                    DAM DATA
                                            TOPEL     COQD     EXPD   DAMWID
                                           1380.0      0.0      0.0       0.

                                                DAM BREACH DATA
                                  BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                                     0.      .50  1352.00      .25  1374.00  1380.00
PLAN
 (1)    BEGIN DAM FAILURE AT 17.75 HOURS

        PEAK OUTFLOW IS     4596. AT TIME  18.00 HOURS
                                                DAM BREACH DATA
                                  BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                                   250.     1.00  1352.00      .25  1374.00  1380.00

 (2)    BEGIN DAM FAILURE AT 17.75 HOURS

        PEAK OUTFLOW IS     8478. AT TIME  17.84 HOURS
                                                DAM BREACH DATA
                                  BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                                     0.      .50  1352.00     4.00  1374.00  1380.00

 (3)    BEGIN DAM FAILURE AT 17.75 HOURS

        PEAK OUTFLOW IS     2625. AT TIME  20.08 HOURS
                                                DAM BREACH DATA
                                  BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                                   250.     1.00  1352.00     4.00  1374.00  1380.00

 (4)    BEGIN DAM FAILURE AT 17.75 HOURS

        PEAK OUTFLOW IS     2776. AT TIME  19.42 HOURS
                                                DAM BREACH DATA
                                  BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                                   100.     1.00  1352.00     1.00  1374.00  1380.00

 (5)    BEGIN DAM FAILURE AT 17.75 HOURS
```

SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY VJV DATE 2-28-79 PROJ. NO. 79-617-423

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .083 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
17.750	0.000	1764.		1764.		0.	0.	0.
17.771	.021	1956.		1911.		45.	45.	0.
17.792	.042	2149.		2088.		61.	106.	0.
17.813	.063	2341.		2308.		33.	139.	0.
17.833	.083	2534.		2534.		0.	139.	0.
17.854	.104	2687.		2731.		-44.	95.	0.
17.875	.125	2841.		2896.		-55.	40.	0.
17.896	.146	2994.		3028.		-34.	6.	0.
17.917	.167	3147.		3147.		0.	6.	0.
17.938	.188	3210.		3242.		-32.	-26.	-0.
17.958	.208	3272.		3310.		-38.	-65.	-0.
17.979	.229	3334.		3363.		-29.	-94.	-0.
18.000	.250	3397.		3397.		0.	-94.	-0.
18.021	.271	3421.		3426.		-5.	-99.	-0.
18.042	.292	3446.		3454.		-8.	-107.	-0.
18.063	.313	3471.		3471.		-1.	-107.	-0.
18.083	.333	3495.		3495.		0.	-107.	-0.
18.104	.354	3517.		3506.		11.	-97.	-0.
18.125	.375	3539.		3535.		4.	-93.	-0.
18.146	.396	3561.		3550.		10.	-82.	-0.
18.167	.417	3582.		3582.		0.	-82.	-0.
18.188	.437	3565.		3588.		-23.	-106.	-0.
18.208	.458	3548.		3575.		-28.	-133.	-0.
18.229	.479	3530.		3549.		-18.	-152.	-0.
18.250	.500	3513.		3513.		0.	-152.	-0.
18.271	.521	3467.		3471.		-4.	-156.	-0.
18.292	.542	3421.		3425.		-4.	-160.	-0.
18.313	.562	3375.		3378.		-3.	-163.	-0.
18.333	.583	3329.		3329.		0.	-163.	-0.
18.354	.604	3282.		3281.		1.	-161.	-0.
18.375	.625	3235.		3233.		2.	-160.	-0.
18.396	.646	3187.		3186.		2.	-158.	-0.
18.417	.667	3140.		3140.		0.	-158.	-0.
18.438	.687	3098.		3096.		2.	-156.	-0.
18.458	.708	3056.		3053.		3.	-153.	-0.
18.479	.729	3014.		3011.		2.	-151.	-0.
18.500	.750	2971.		2971.		0.	-151.	-0.
18.521	.771	2935.		2933.		2.	-148.	-0.
18.542	.792	2899.		2896.		3.	-145.	-0.
18.563	.812	2863.		2861.		2.	-143.	-0.
18.583	.833	2827.		2827.		0.	-143.	-0.
18.604	.854	2796.		2794.		2.	-141.	-0.
18.625	.875	2766.		2763.		3.	-138.	-0.
18.646	.896	2735.		2733.		2.	-136.	-0.
18.667	.917	2705.		2705.		0.	-136.	-0.
18.688	.937	2680.		2678.		2.	-134.	-0.
18.708	.958	2655.		2653.		3.	-131.	-0.
18.729	.979	2630.		2628.		2.	-129.	-0.
18.750	1.000	2606.		2606.		0.	-129.	-0.

5

SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY NJV DATE 2-28-79 PROJ. NO. 78-617-423

CHKD. BY DLB DATE 2-28-79 SHEET NO. M OF

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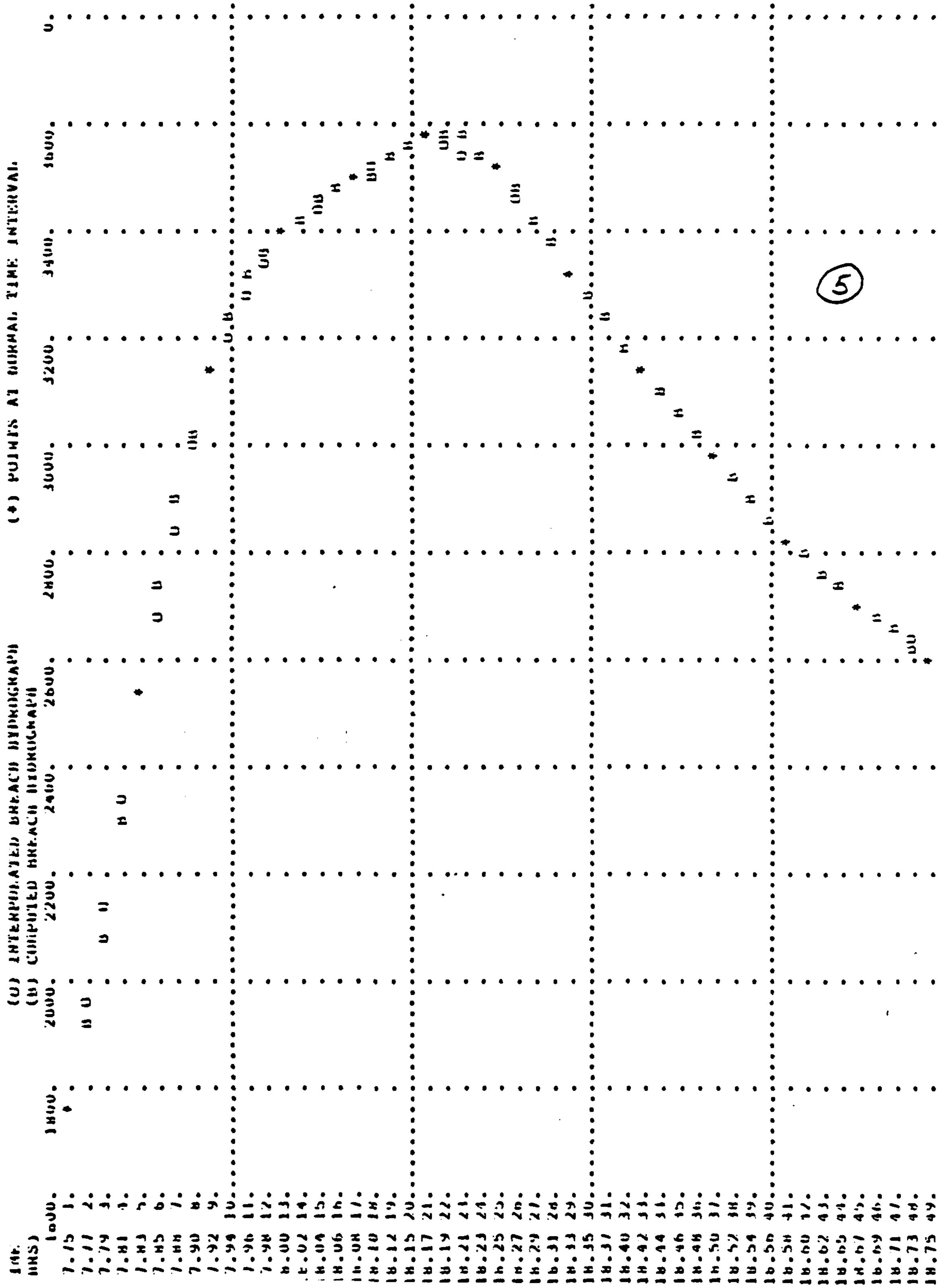

SUBJECT DAM SAFETY INSPECTION

MOOSE CREEK RESERVOIR

BY NJV DATE 2-28-79 PROJ. NO. 79-617-423

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SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1374.00	1374.00	1380.00
STORAGE	52.	52.	87.
OUTFLOW	0.	0.	1660.

PLAN	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1	.50	1380.07	.07	88.	4678.	.18	16.75	16.50
	.30	1380.08	.08	88.	4596.	.18	18.00	17.75
2	.50	1380.01	.01	87.	8521.	.09	16.59	16.50
	.30	1380.06	.06	88.	8476.	.09	17.84	17.75
3	.50	1380.71	.71	92.	4367.	3.08	20.00	16.50
	.30	1380.29	.29	89.	2625.	2.00	20.08	17.75
4	.50	1380.02	.02	87.	4258.	.17	19.67	16.50
	.30	1380.06	.06	88.	2776.	.17	19.42	17.75
5	.50	1380.03	.03	87.	4120.	.13	19.83	16.50
	.30	1380.07	.07	88.	3588.	.13	18.19	17.75

MOOSE CREEK RESERVOIR DAM

ROUTE FROM RESERVOIR TO SECTION 2 * 4800 FT DOWNSTREAM

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.50	4108.	1251.0	20.08
	.30	3244.	1250.1	18.08
2	.50	4826.	1251.5	16.67
	.30	4838.	1251.6	17.92
3	.50	4355.	1251.2	20.17
	.30	2619.	1249.3	20.42
4	.50	4251.	1251.1	19.75
	.30	2771.	1249.5	19.58
5	.50	4112.	1251.0	19.92
	.30	3378.	1250.3	18.33

@ 1st HOUSE

(≈ EL. 1248 FT)

SUBJECT: DAM SAFETY INSPECTION
MOOSE CREEK RESERVOIR

BY: VJV DATE: 2-28-79 PROJ. NO. 78-617-423

CHKD. BY: DLB DATE: 2-28-79 SHEET NO. 0 OF

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ROUTE FROM SECTION 2 THROUGH THE DS HWY EMBANKMENT :SEC 3 + 800FT DS OF SEC 2

....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1225.00	1240.00	1240.00
STORAGE	0.	28.	28.
OUTFLOW	0.	7680.	7680.

PLAN	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1	.50	1234.53	0.00	7.	4108.	0.00	20.08	0.00
	.30	1233.06	0.00	4.	3190.	0.00	18.17	0.00
2	.50	1235.52	0.00	9.	4757.	0.00	16.75	0.00
	.30	1235.50	0.00	9.	4745.	0.00	18.00	0.00
3	.50	1234.93	0.00	8.	4354.	0.00	20.25	0.00
	.30	1232.04	0.00	3.	2619.	0.00	20.42	0.00
4	.50	1234.76	0.00	8.	4251.	0.00	19.83	0.00
	.30	1232.32	0.00	3.	2771.	0.00	19.58	0.00
5	.50	1234.54	0.00	7.	4112.	0.00	20.00	0.00
	.30	1233.35	0.00	5.	3370.	0.00	18.33	0.00

US ROUTE 322 HIGHWAY EMBANKMENT "DAM"

ROUTE FROM HIGHWAY EMBANKMENT TO SECTION 4 + 500 FT DOWNSTREAM OF EMBANKMENT

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.50	4107.	1227.3	20.08
	.30	3204.	1226.1	18.17
2	.50	4672.	1227.8	16.75
	.30	4672.	1227.8	18.00
3	.50	4354.	1227.6	20.25
	.30	2619.	1225.4	20.50
4	.50	4251.	1227.4	19.83
	.30	2771.	1225.5	19.58
5	.50	4112.	1227.3	20.00
	.30	3361.	1226.3	18.33

WITHIN MAJOR DAMAGE CENTER W/ BUILDINGS @ ≈ EL. 1225

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15. Engineering Field Manual, U. S. Department of Agriculture, Soil Conservation Service, 2nd Edition, Washington, D. C. 1969.

APPENDIX D

PHOTOGRAPHS

PHOTOGRAPH 1	Overview of Moose Creek Reservoir Dam from the right abutment. Both the new and old gate houses can be seen at the toe of the dam. *The spillway is in the foreground of the photograph.*
PHOTOGRAPH 2	View of Moose Creek Reservoir Dam from a point a few hundred feet downstream of the dam. The spillway is visible on the extreme left portion of the photograph.
PHOTOGRAPH 3	View of the impoundment and the slopes surrounding Moose Creek Reservoir.
PHOTOGRAPH 4	View of the hand-placed, sandstone riprap on the upstream face of Moose Creek Reservoir Dam.

1

2

3

4

PHOTOGRAPH 5	View of the area immediately downstream of Moose Creek Reservoir Dam as seen from the crest of the dam.
PHOTOGRAPH 6	View of the spillway at Moose Creek Reservoir Dam.
PHOTOGRAPH 7	View of the discharge end of the blowoff pipe.
PHOTOGRAPH 8	View of seepage at the toe of the dam near the old gate house.


5


6


7


8

PHOTOGRAPH 9 View of seepage of the toe of the dam along the left abutment contact.

PHOTOGRAPH 10 View of Moose Creek at a point approximately 5,600 feet downstream of the dam. Note the dwelling near the left center portion of the photograph.

9

10

APPENDIX E

GEOLOGY

Geology

Moose Creek Reservoir Dam is located in the Pittsburgh Plateaus Section of the Appalachian Plateaus Physiographic Province of Western Pennsylvania, two miles northwest of the Borough of Clearfield.

This section is characterized as a high plateau underlain by flat-lying to gently folded sedimentary rock strata of Pennsylvanian and Mississippian age.

Structurally, the site lies approximately midway between the Clearfield syncline to the southeast and the Chestnut Ridge anticline to the northwest. Consequently, the rock strata at the dam site dip to the southeast at approximately 300 feet per mile or about 3 degrees. The axes of both structures follow the regional trend which is generally in a northeast-southwest direction.

The dam is founded on sedimentary rocks of the Mississippian age Pocono Formation. In this area, the upper 30 to 50 feet of the Pocono consist of fine to medium grained, very light gray, quartzose sandstone. Bedding thickness in the unit ranges from a few inches to 6 feet. Underlying this upper sandstone is a 30- to 40-foot gray to black, silty shale section. This unit becomes silty and sandy toward the top and bottom, and includes several thin beds of sandstone and siltstone. Underlying the silty shale section is an 85- to 90-foot thick very fine to medium grained sandstone.

Since the Mississippian-Pennsylvanian disconformity is located on the hillside approximately 50 feet above the crest, the embankment is presumably founded on bedrock of the silty shale and lower sandstone section.

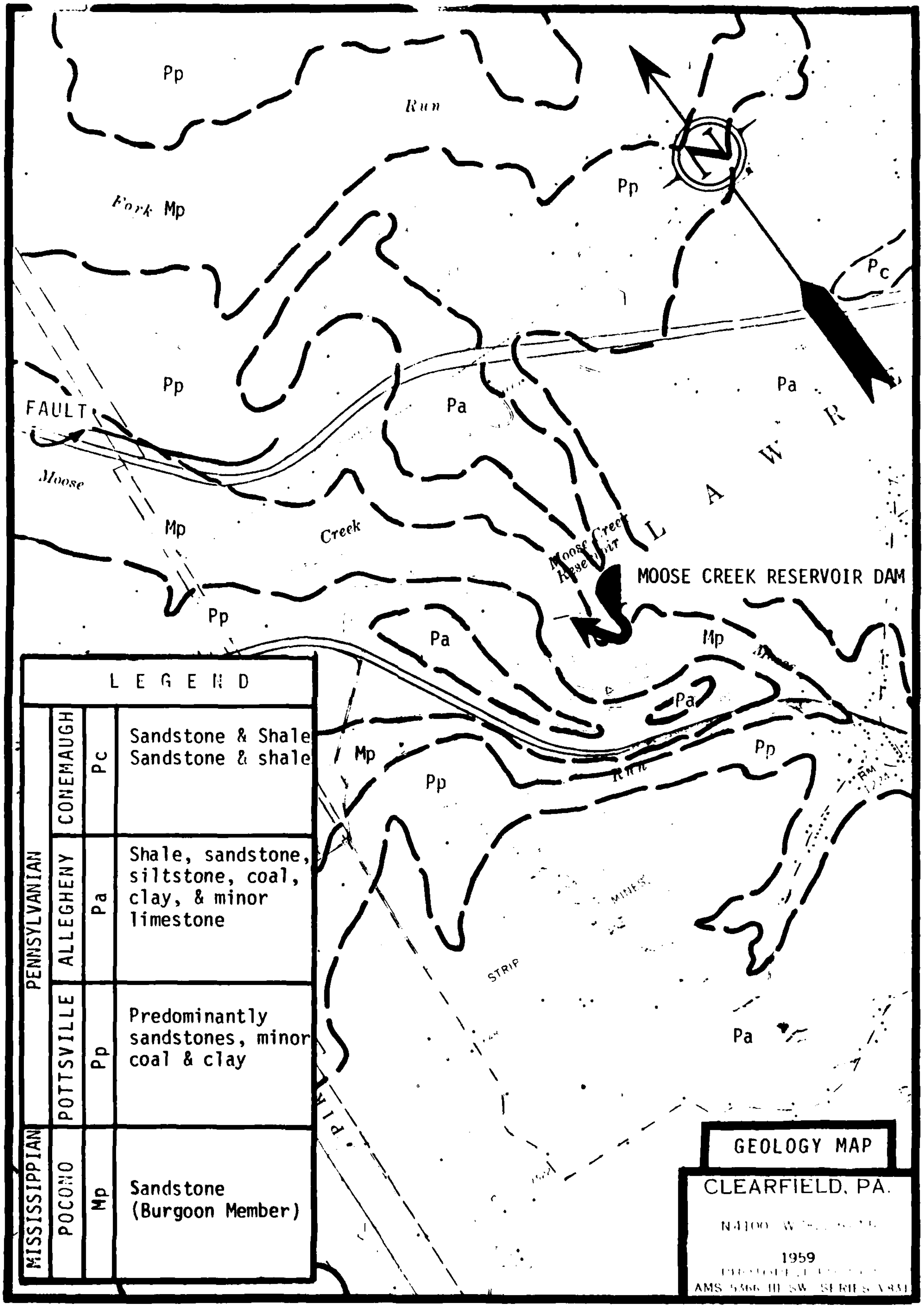
Sedimentary rocks of the Pottsville, Allegheny, and Conemaugh Groups lie stratigraphically above the Mississippian-Pennsylvanian disconformity and form the hilltops surrounding Clearfield.

Two principal joint set directions are common to the Moose Creek Reservoir Dam area. The major set ranged from N30°W to N50°W. This set is roughly perpendicular to the trend of the major folds in the area. The strike of the secondary set ranges N70°E to N85°E or roughly parallel to the trend of the major folds in the area.

Faulting is also common, particularly to the east of the Moose Creek Reservoir Dam, where a series of high angle wrench faults traverse the region in a range from N30°W to N55°W. A correlation is obvious between primary joint direction, the strike of the faults and the alignment of many of the first order tributaries to the West Branch of the Susquehanna River. Moose Creek, Lick Run, Stone Run, and Millstone Run are just a few of the tributaries showing topographic lineaments which correspond to the major joint and fault directions in the region. Some of the lineaments are directly associated with known wrench faults in the area whereas others (as is the case with the Moose Creek Valley) are not associated with known faults. In any case, there is considerable evidence for structural control on drainage patterns in the dam area.

Below the dam and reservoir, the narrow Moose Creek floodplain is floored by a thin alluvial deposit that joins the broad floodplain of the Susquehanna River in the Borough of Clearfield, Pennsylvania.

Glover, Albert D., "Geology and Mineral Resources of the Southern Half of the Clearfield 15-Minute Quadrangle, Survey, Pennsylvania," Harrisburg: Topographic and Geologic Atlas A84cd, 1970.


Pp
Run
Fork Mp
Pp
Pc
Pp
Pa
Pa
FAULT
Moose
Mp
Creek
Moose Creek Reservoir
L A W R
MOOSE CREEK RESERVOIR DAM
Pp
Pa
Mp
Pa
Mp
Pp
Pp
Run
STRIP
MINES
Pa
LEGEND
PENNSYLVANIAN
CONEMAUGH
Pc
Sandstone & Shale
Sandstone & shale
ALLEGHENY
Pa
Shale, sandstone, siltstone, coal, clay, & minor limestone
POTTSVILLE
Pp
Predominantly sandstones, minor coal & clay
MISSISSIPPIAN
POCONO
Mp
Sandstone (Burgoon Member)
GEOLOGY MAP
CLEARFIELD, PA.
1959
AMS

APPENDIX F

FIGURES

LIST OF FIGURES

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NATIONAL DAM INSPECTION PROGRAM. MOOSE CREEK RESERVOIR DAM. (ND--ETC(U)
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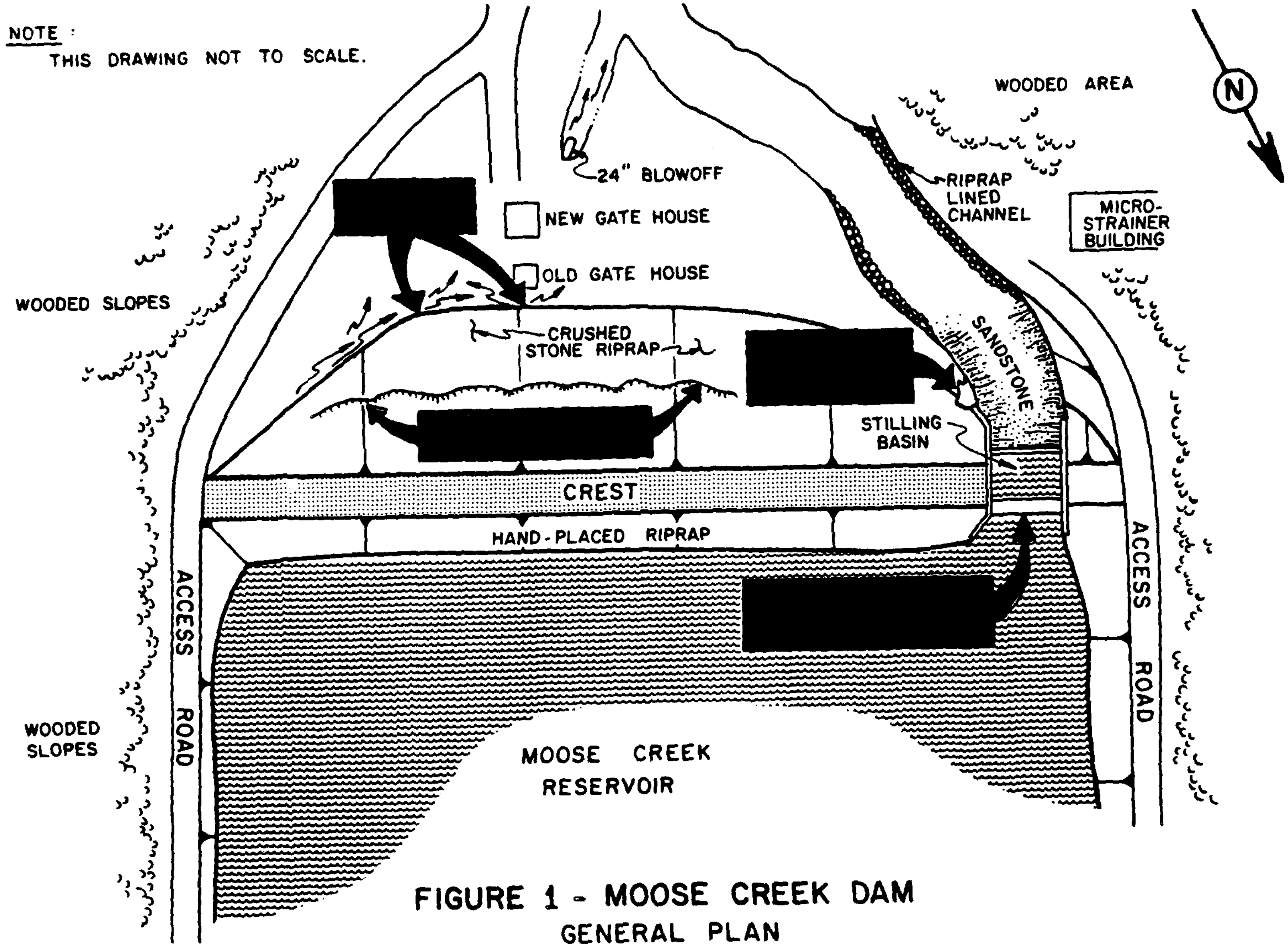
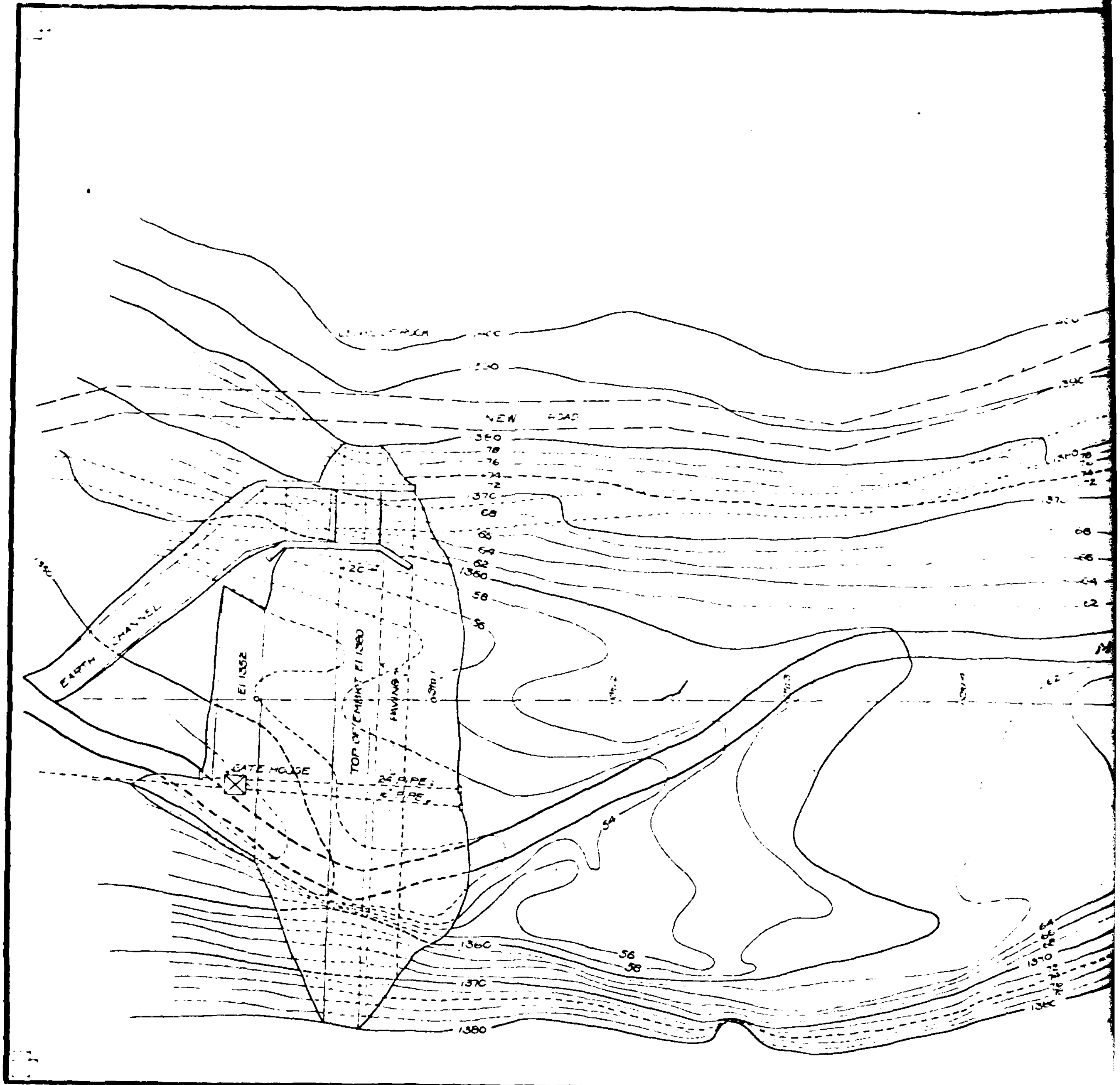


FIGURE 1 - MOOSE CREEK DAM
GENERAL PLAN
FIELD INSPECTION NOTES



NEW ROAD
EARTH CHANNEL
El 1352
TOP OF EMBANKT El 1380
PAVING
GATE HOUSE
24" PIPES
1360
1370
1380
1390
1400

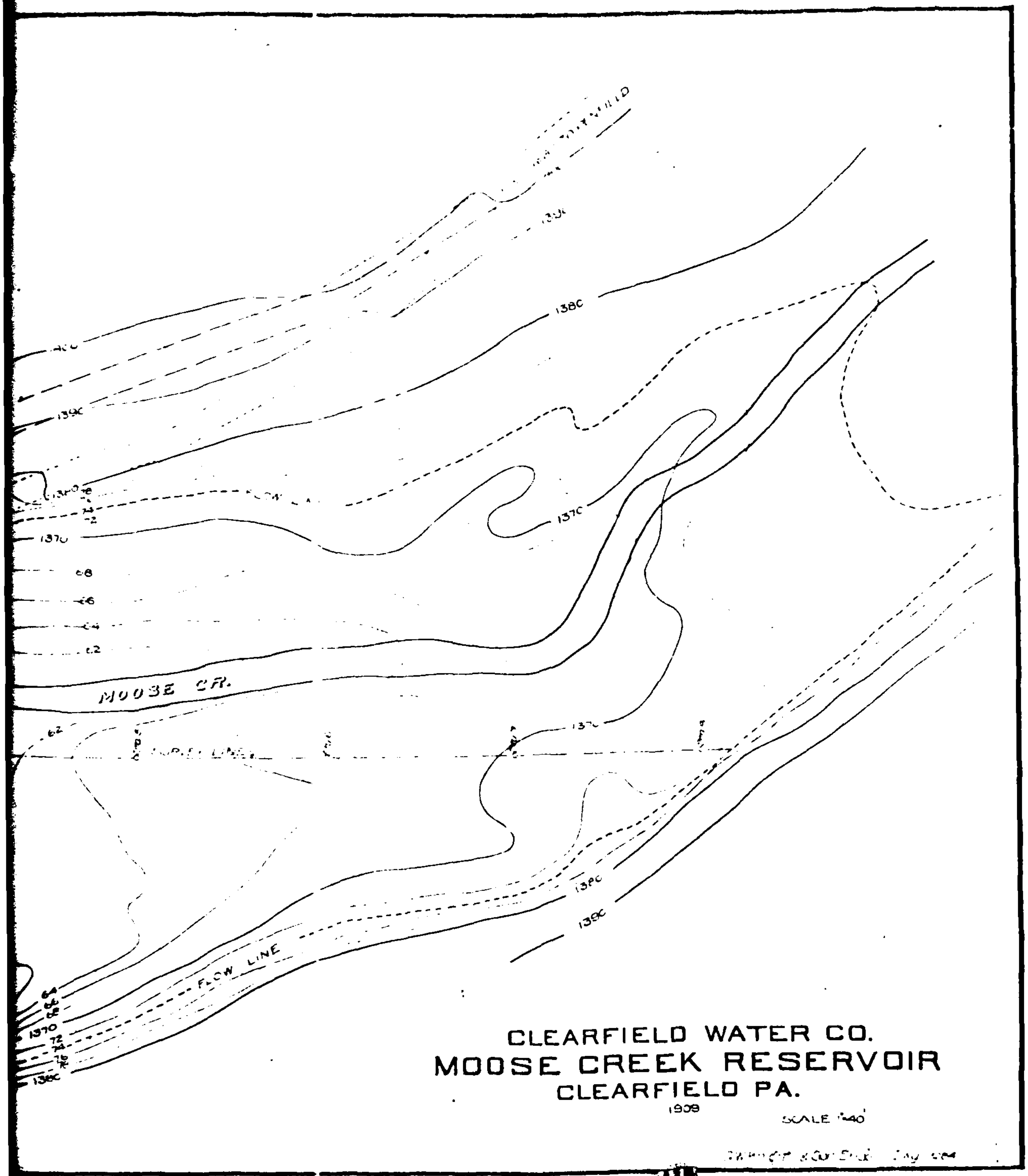
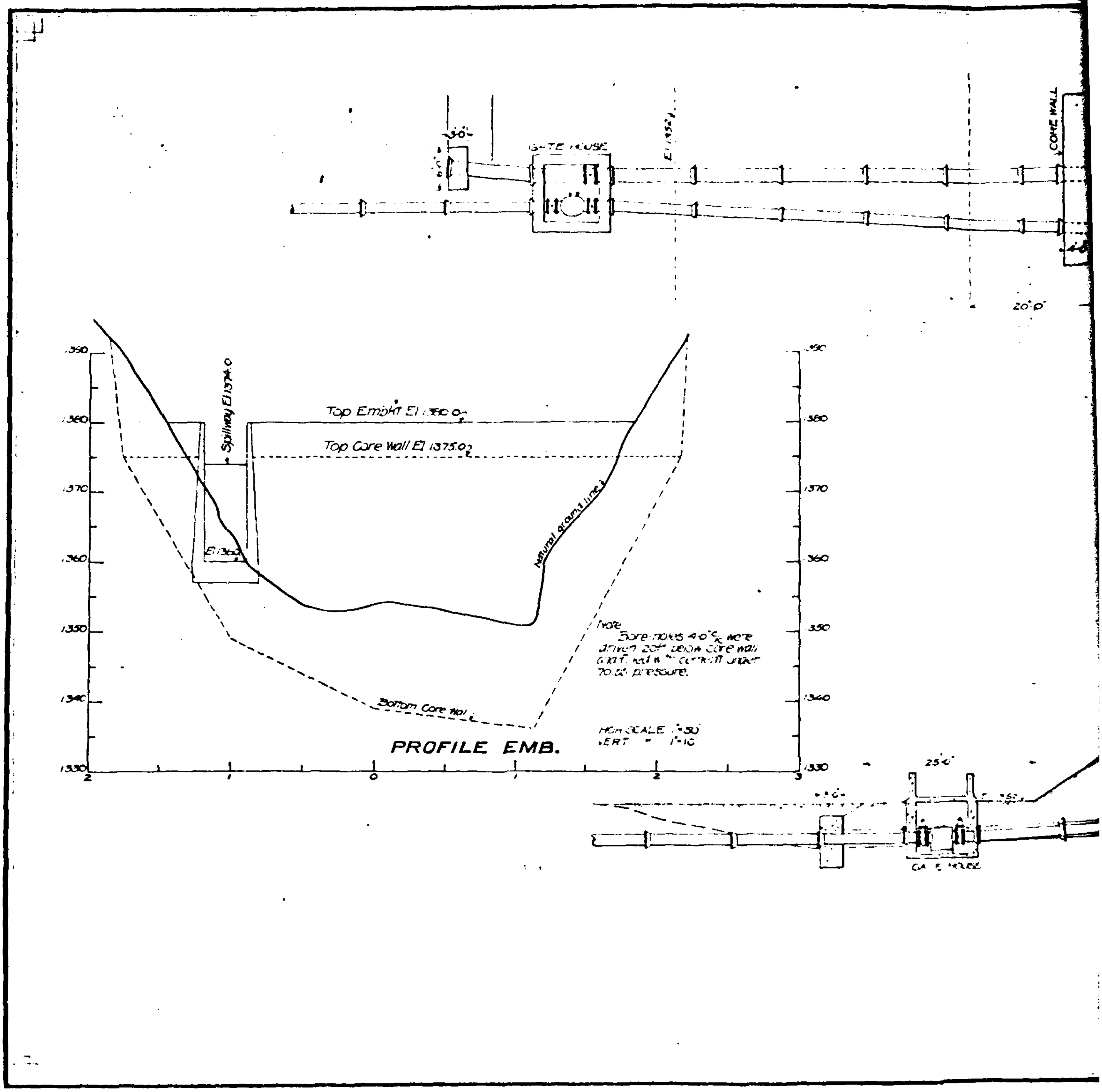

CLEARFIELD WATER CO.
MOOSE CREEK RESERVOIR
CLEARFIELD PA.
1909
MOOSE CR.
FLOW LINE
1380
1390
1370

FIGURE 2


GATE HOUSE
CORE WALL
20'0"
Spillway El 1374.0
Top Core Wall El 1375.0
Natural ground line
Bottom Core Wall
PROFILE EMB.
25'0"

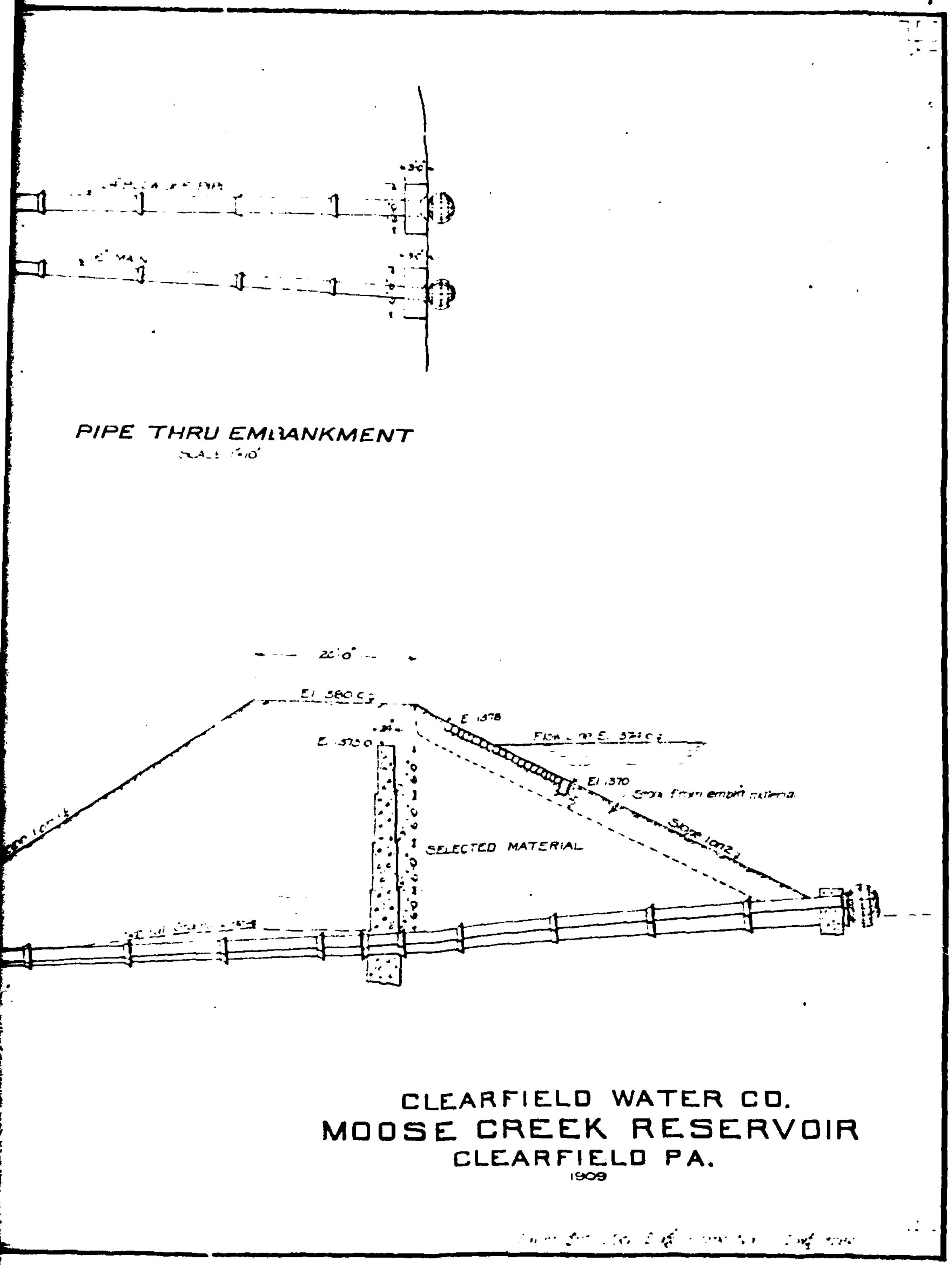
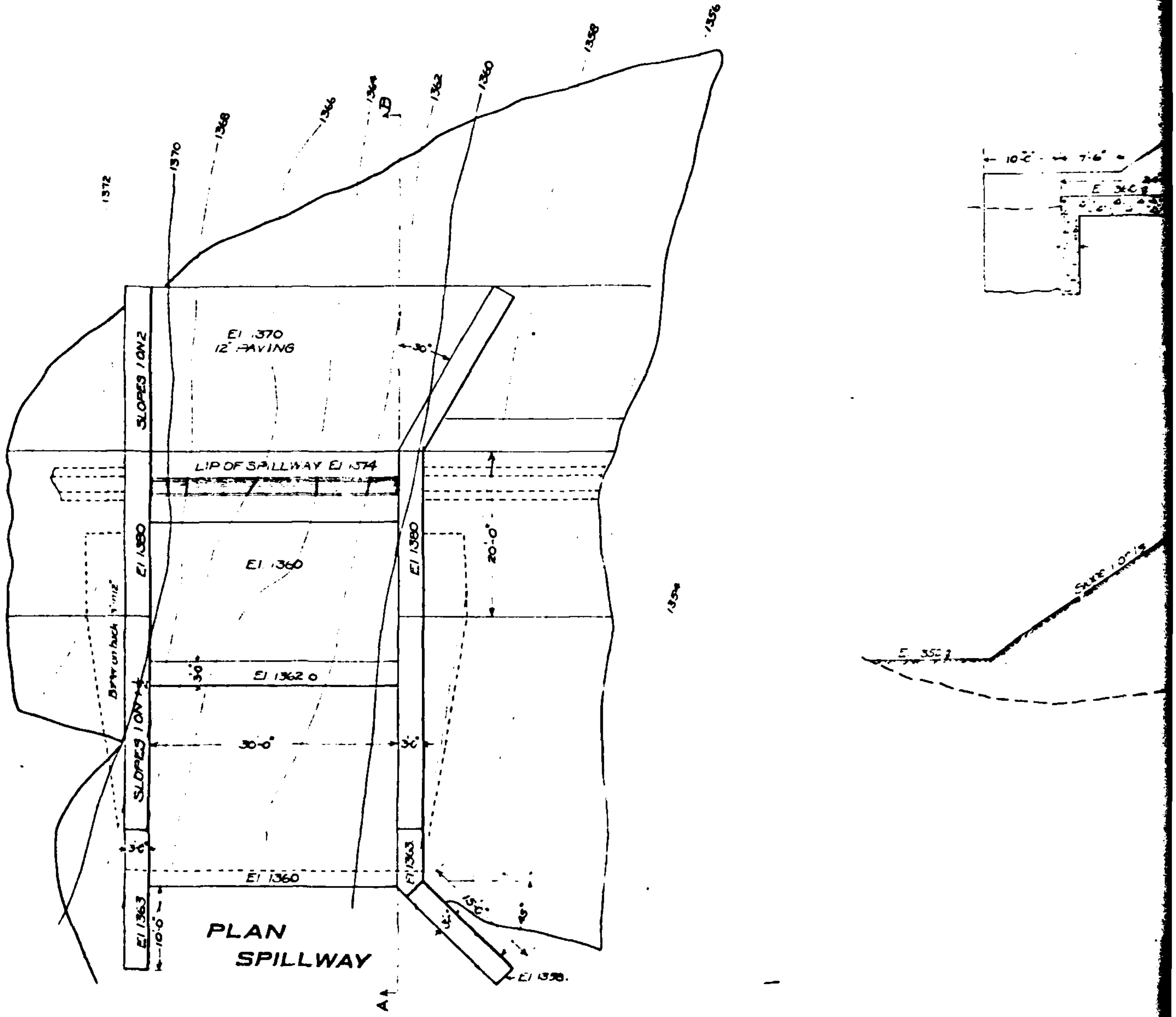
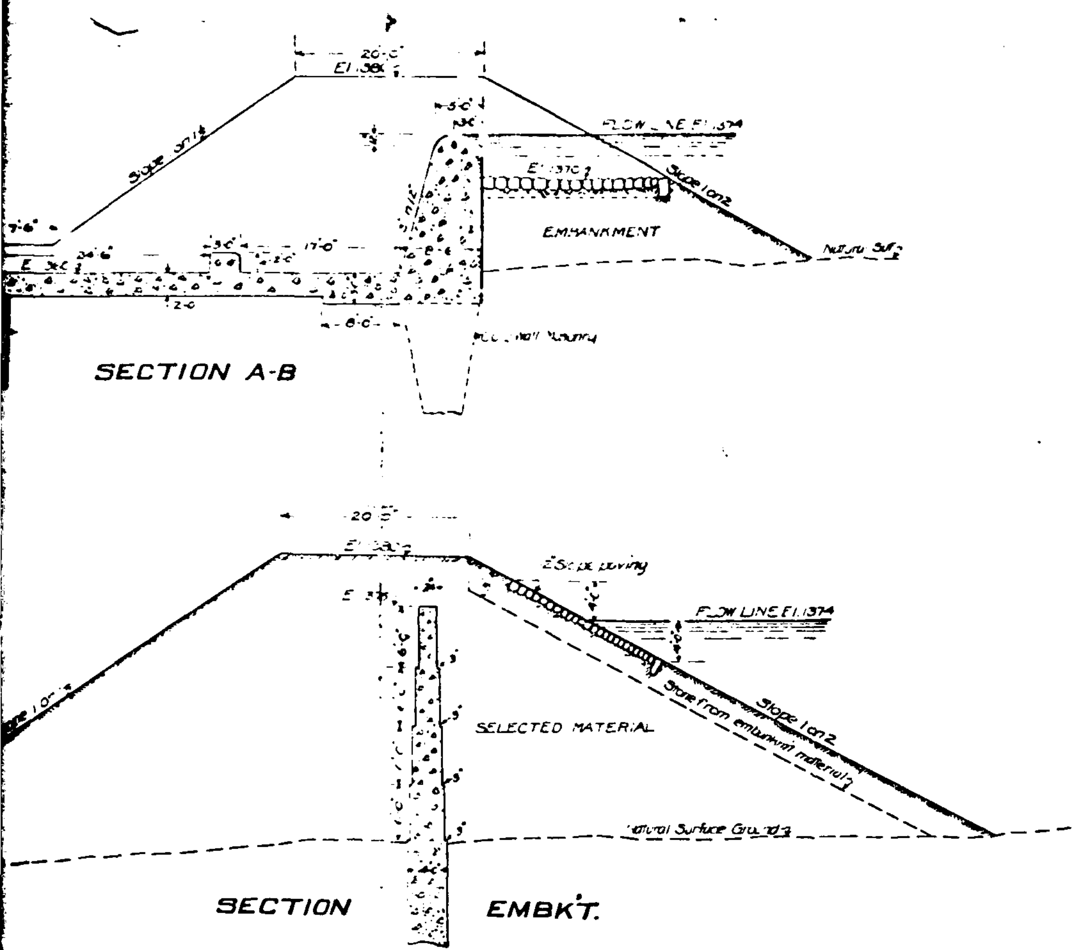

PIPE THRU EMBANKMENT
SELECTED MATERIAL
CLEARFIELD WATER CO.
MOOSE CREEK RESERVOIR
CLEARFIELD PA.
1909

FIGURE 3



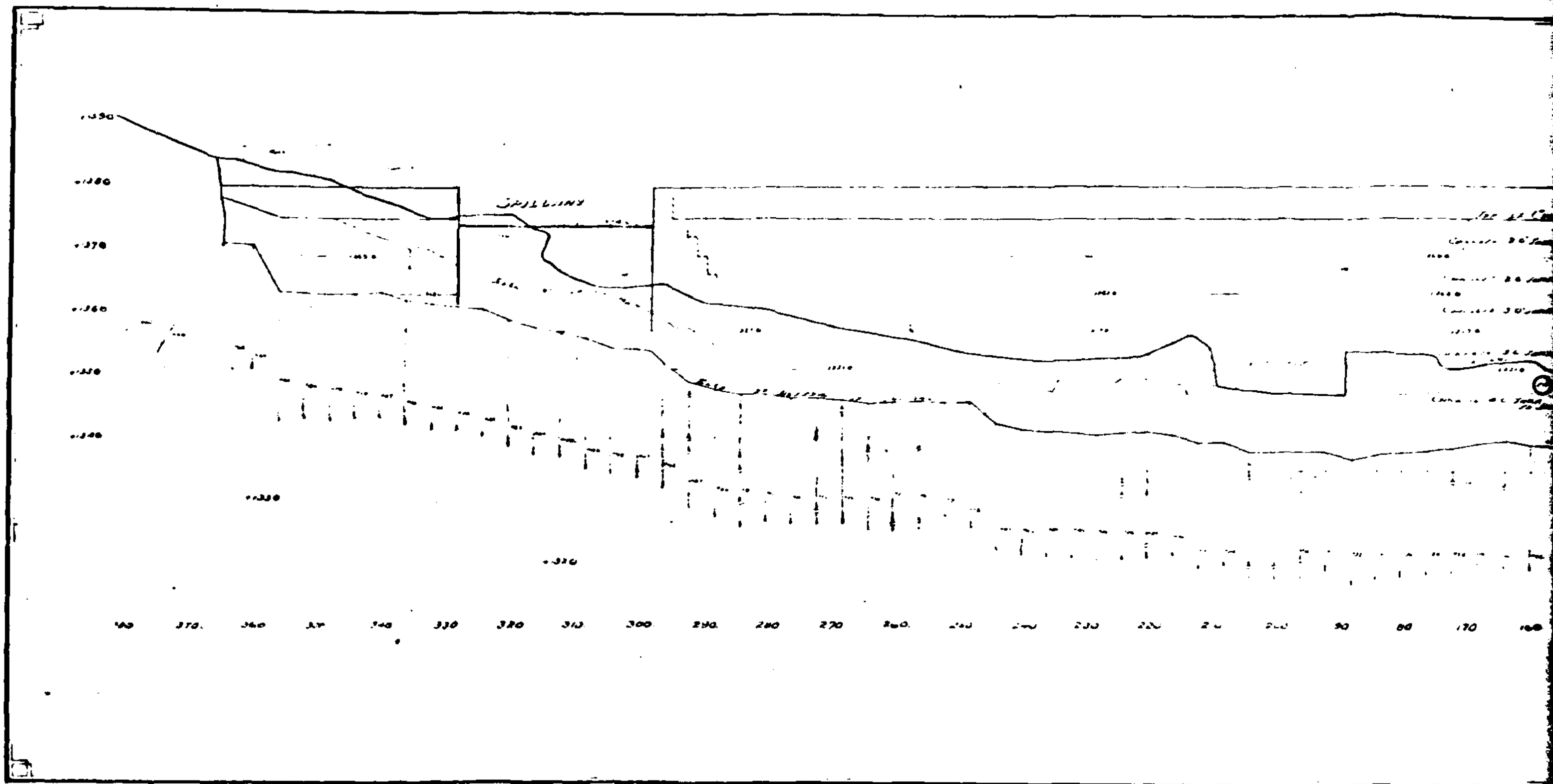
PLAN
SPILLWAY



CLEARFIELD WATER CO.
MOOSE CREEK RESERVOIR
CLEARFIELD PA.
1909
SCALE 1"=10'

C.W. Knight & Son Engs. Rome N.Y. Dwg. 3288

FIGURE 4



330
320
300
280
270

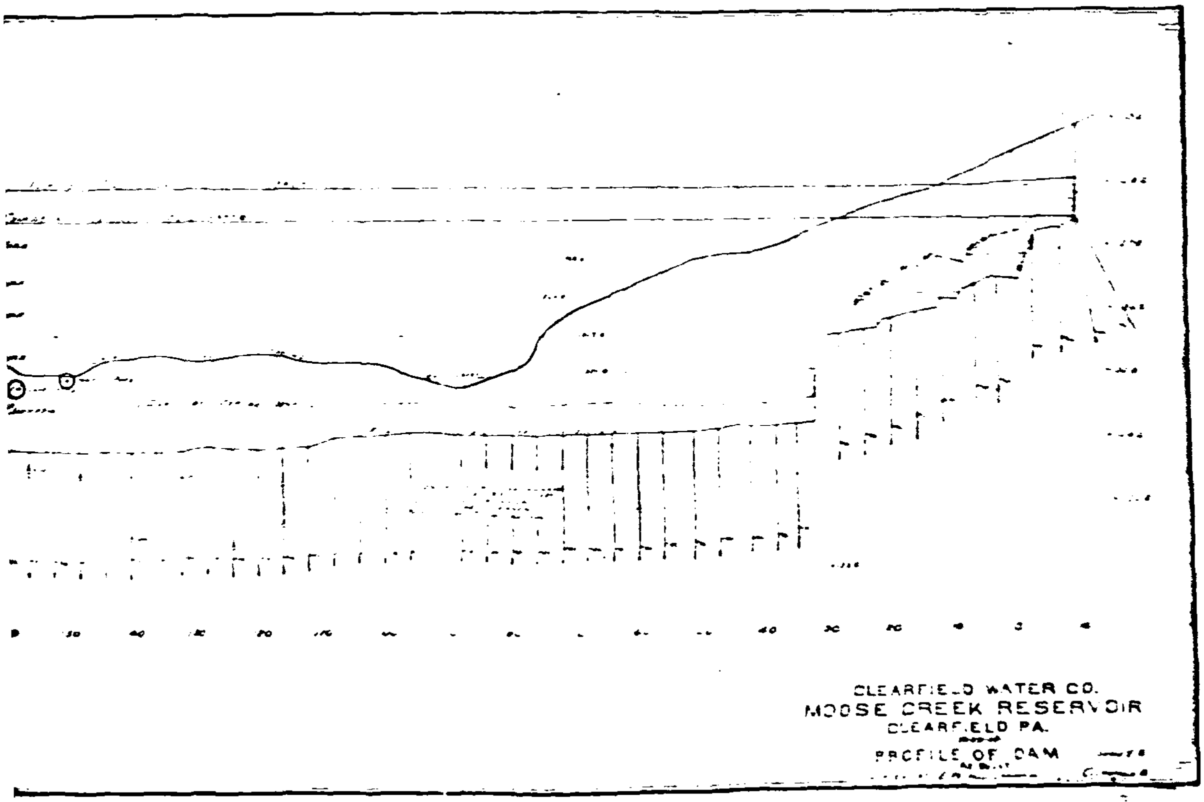
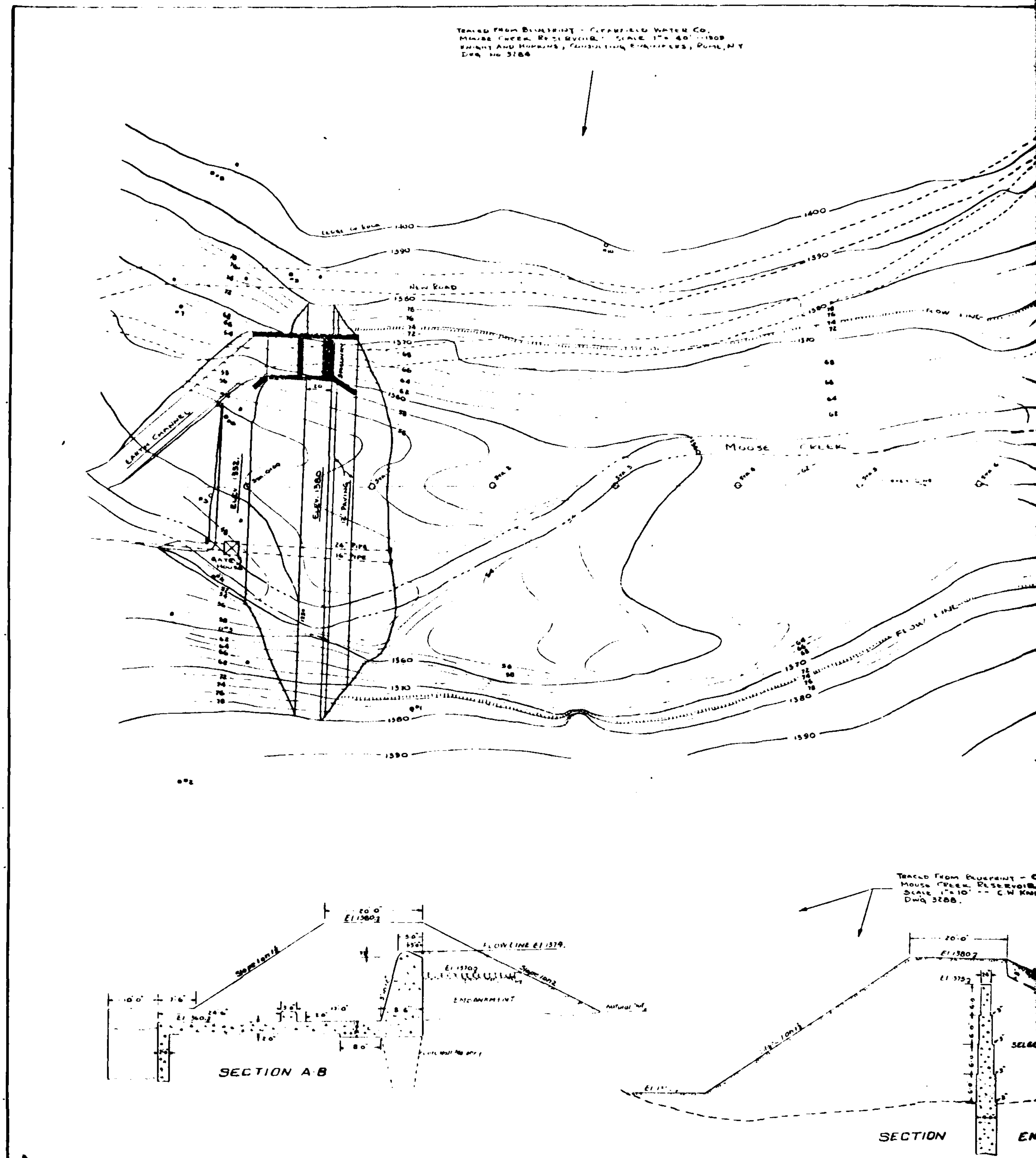

CLEARFIELD WATER CO.
MOOSE CREEK RESERVOIR
CLEARFIELD PA.
PROFILE OF DAM

FIGURE 5



TRACED FROM BLUEPRINT - CLEARFIELD WATER CO.
MOOSE CREEK RESERVOIR - SCALE 1"= 40' -- 1909
KNIGHT AND HOPKINS, CONSULTING ENGINEERS, ROME, N.Y.
DWG NO 3284
NEW ROAD
FLOW LINE
MOOSE CREEK
EARTH CHANNEL
GATE HOUSE
ELEV. 1352
ELEV. 1380
26" PIPE
16" PIPE
1400
1390
1380
1370
1360
EMBANKMENT
FLOW LINE EL 1374
SECTION A-B
TRACED FROM BLUEPRINT - C
MOUSE CREEK RESERVOIR
SCALE 1"=10' -- C.W. KN
DWG 3288.
20.0'
El 1380
SECTION

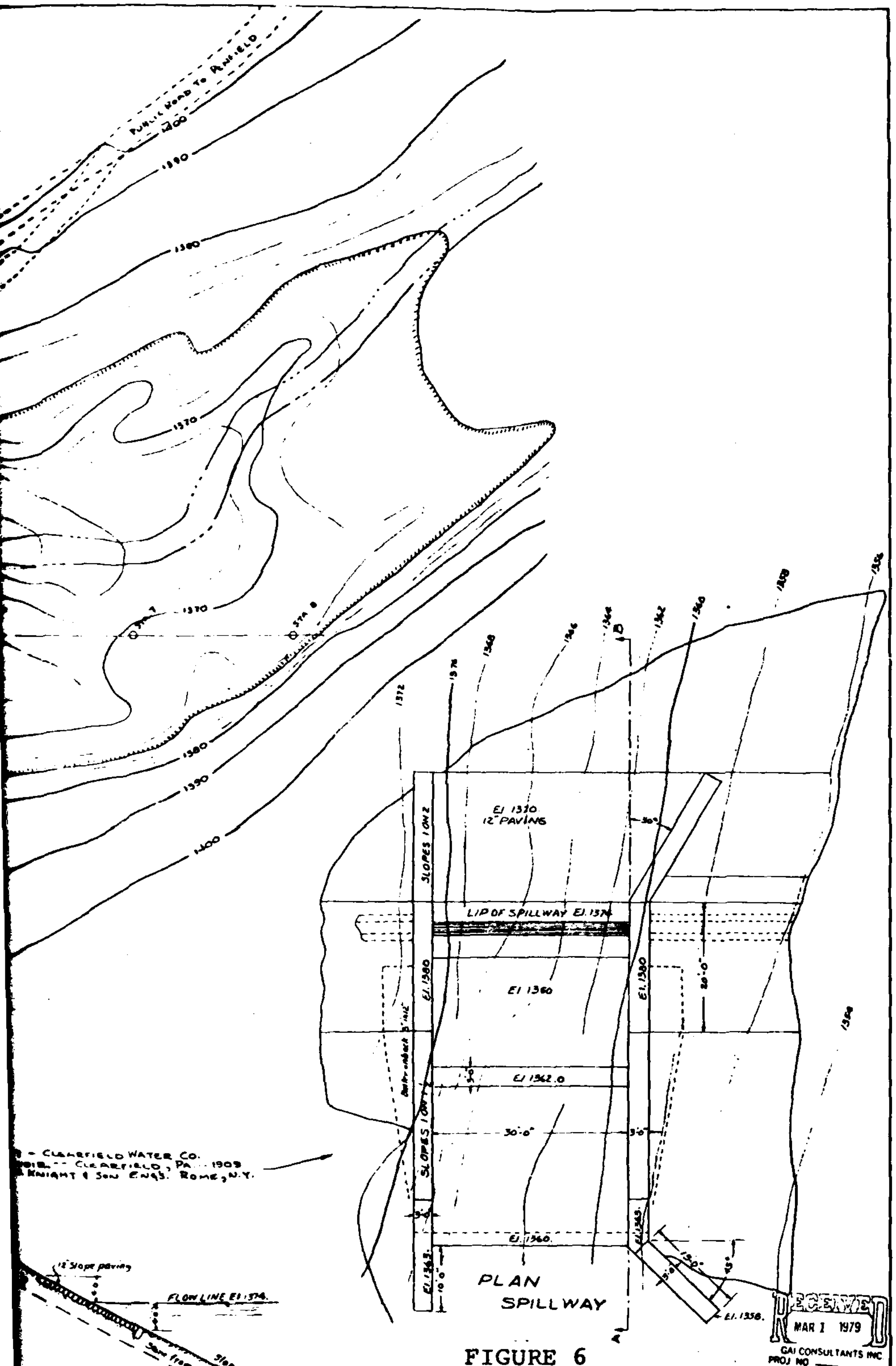
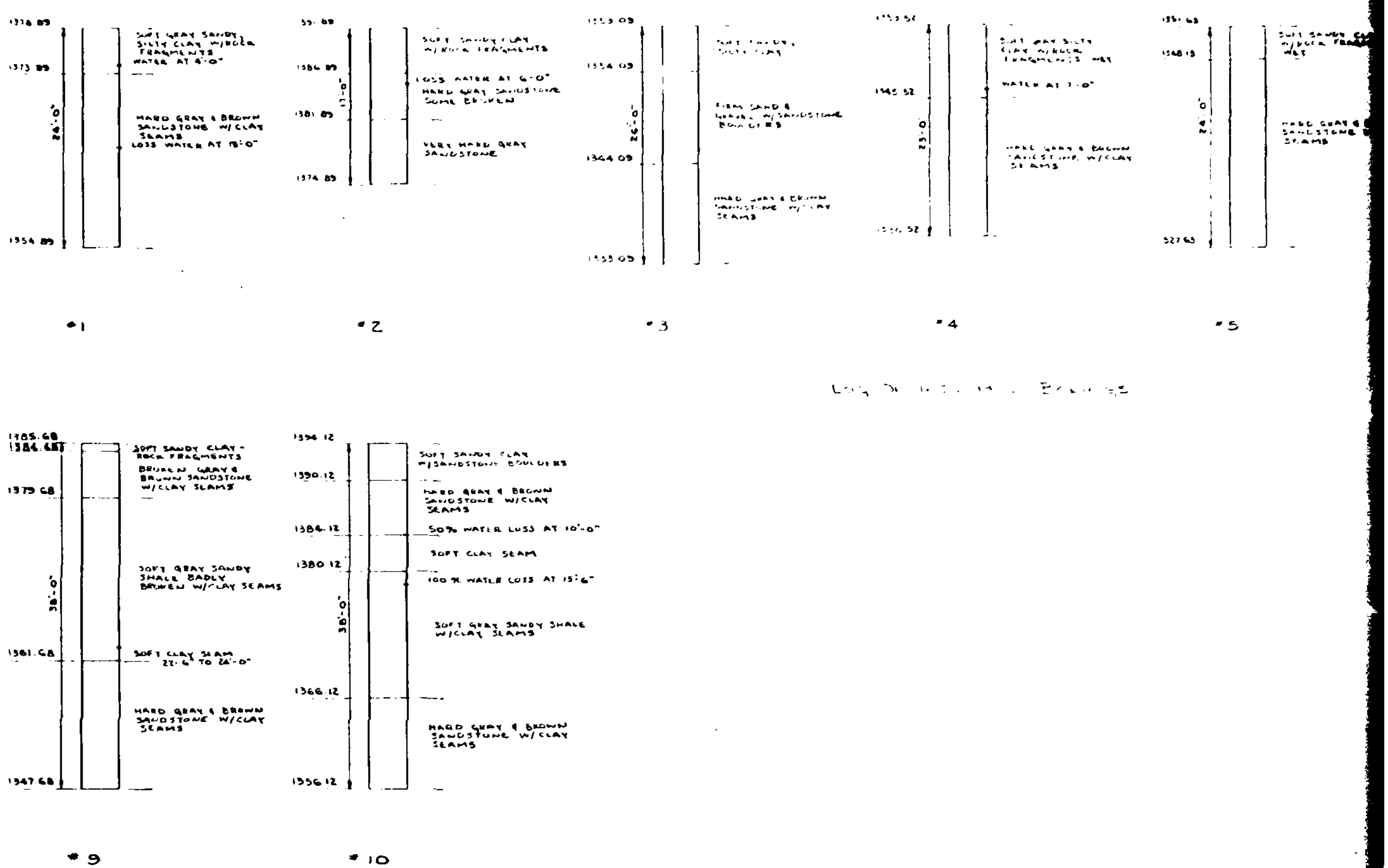
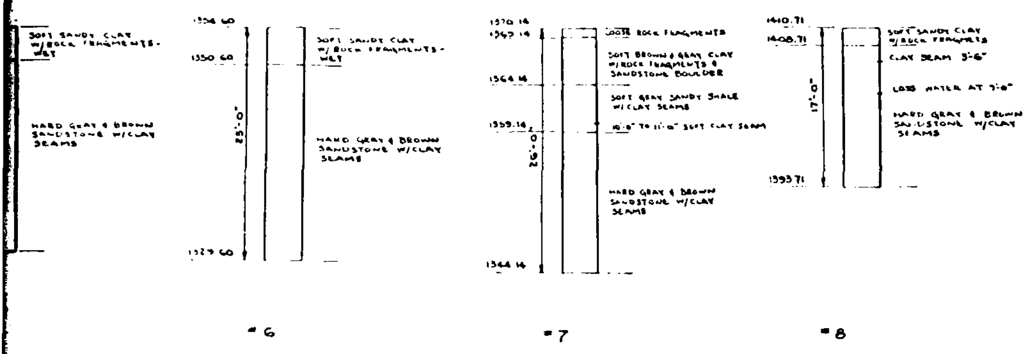


FIGURE 6

REVISIONS	
	CLEARFIELD MUNICIPAL AUTHORITY CLEARFIELD COUNTY, PENNSYLVANIA CLEARFIELD WATER CO. MOOSE CREEK RESERVOIR
	HILL & HILL ENGINEERS, INC. · NORTH EAST, PA.
	DRAWN BY / CHK'D / SCALE: AS NOTED / DRAWING NO.
	TRACED / APPRD / DATE: DEC., 1977



1376.89
SOFT GRAY SANDY SILTY CLAY W/ROCK FRAGMENTS
WATER AT 4'-0"
1373.89
24'-0"
HARD GRAY & BROWN SANDSTONE W/CLAY SEAMS
LOSS WATER AT 15'-0"
1354.89
#1
1384.89
LOSS WATER AT 6'-0"
HARD GRAY SANDSTONE SOME BROKEN
1381.89
VERY HARD GRAY SANDSTONE
1374.89
#2
1354.09
FIRM SAND & GRAVEL W/SANDSTONE BOULDERS
26'-0"
1344.09
HARD GRAY & BROWN SANDSTONE W/CLAY SEAMS
#3
SOFT GRAY SILTY CLAY W/ROCK FRAGMENTS WET
WATER AT 7'-0"
1345.52
23'-0"
HARD GRAY & BROWN SANDSTONE W/CLAY SEAMS
#4
24'-0"
#5
1385.68
1384.68
SOFT SANDY CLAY - ROCK FRAGMENTS
BROKEN GRAY & BROWN SANDSTONE W/CLAY SEAMS
1379.68
SOFT GRAY SANDY SHALE BADLY BROKEN W/CLAY SEAMS
38'-0"
1361.68
SOFT CLAY SEAM 22'-6" TO 24'-0"
HARD GRAY & BROWN SANDSTONE W/CLAY SEAMS
1347.68
#9
1394.12
SOFT SANDY CLAY W/SANDSTONE BOULDERS
1390.12
HARD GRAY & BROWN SANDSTONE W/CLAY SEAMS
1384.12
50% WATER LOSS AT 10'-0"
SOFT CLAY SEAM
1380.12
100% WATER LOSS AT 15'-6"
38'-0"
SOFT GRAY SANDY SHALE W/CLAY SEAMS
1366.12
HARD GRAY & BROWN SANDSTONE W/CLAY SEAMS
1356.12
#10



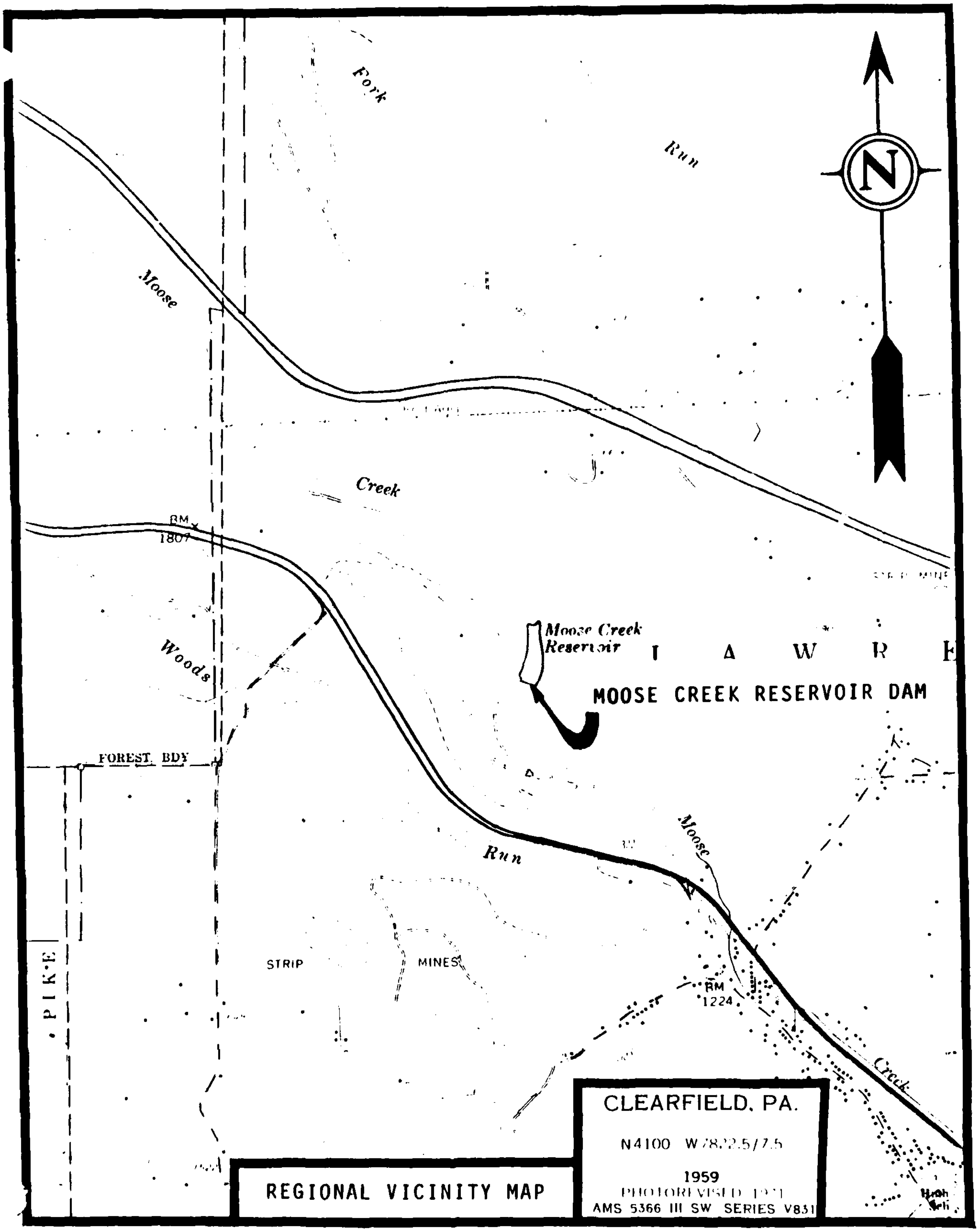
RECEIVED
MAR 1 1979
GAI CONSULTANTS INC
PROJ NO

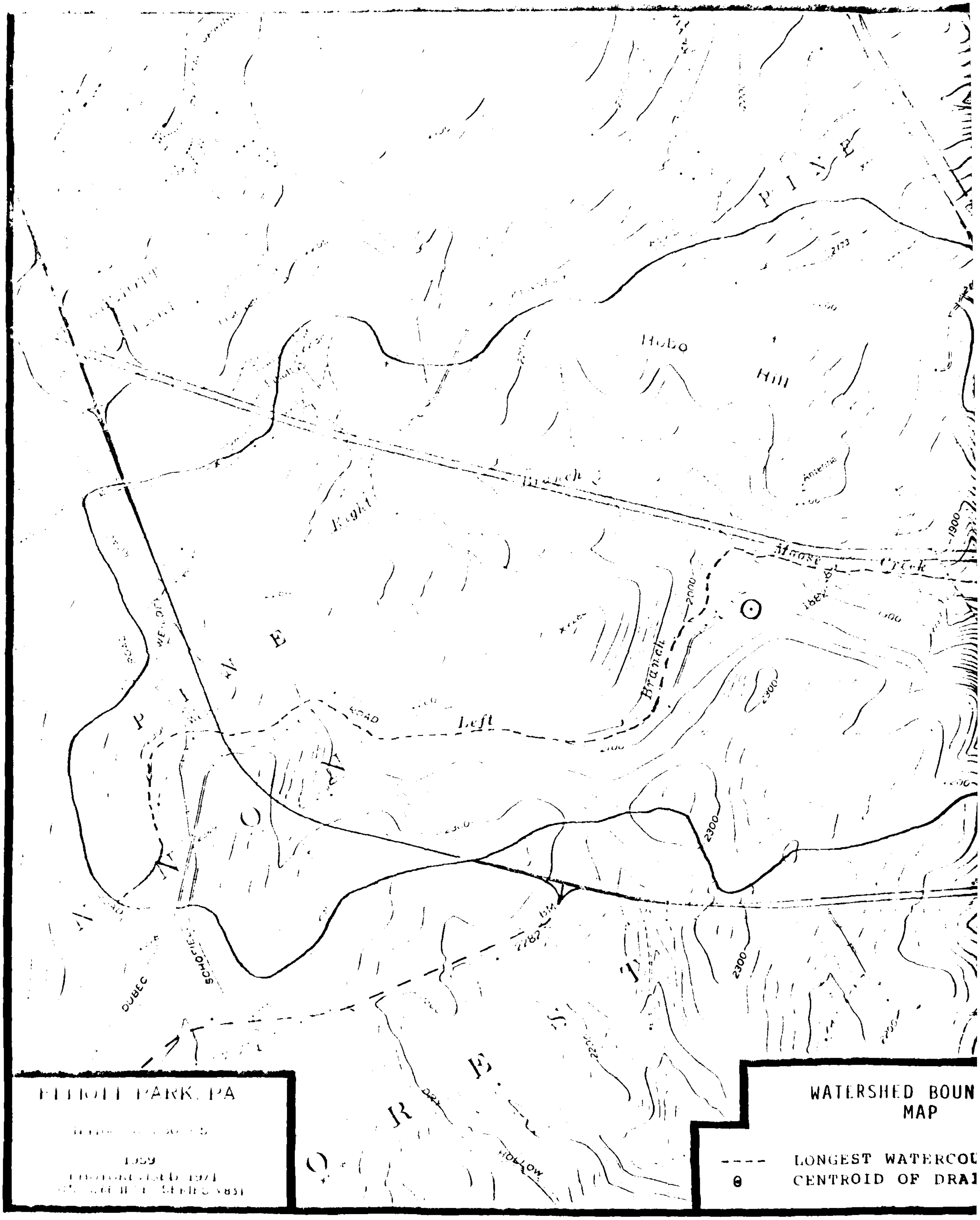
FIGURE 7

REVISIONS	
	CLEARFIELD MUNICIPAL AUTHORITY CLEARFIELD COUNTY, PENNSYLVANIA CLEARFIELD WATER CO. MOOSE CREEK RESERVOIR TEST HOLE BORINGS
	HILL & HILL ENGINEERS, INC. · NORTH EAST, PA.
	DRAWN BY · CHK'D · SCALE As Noted · DRAWING NO.
	TRACED · APP'D · DATE Dec., 1977

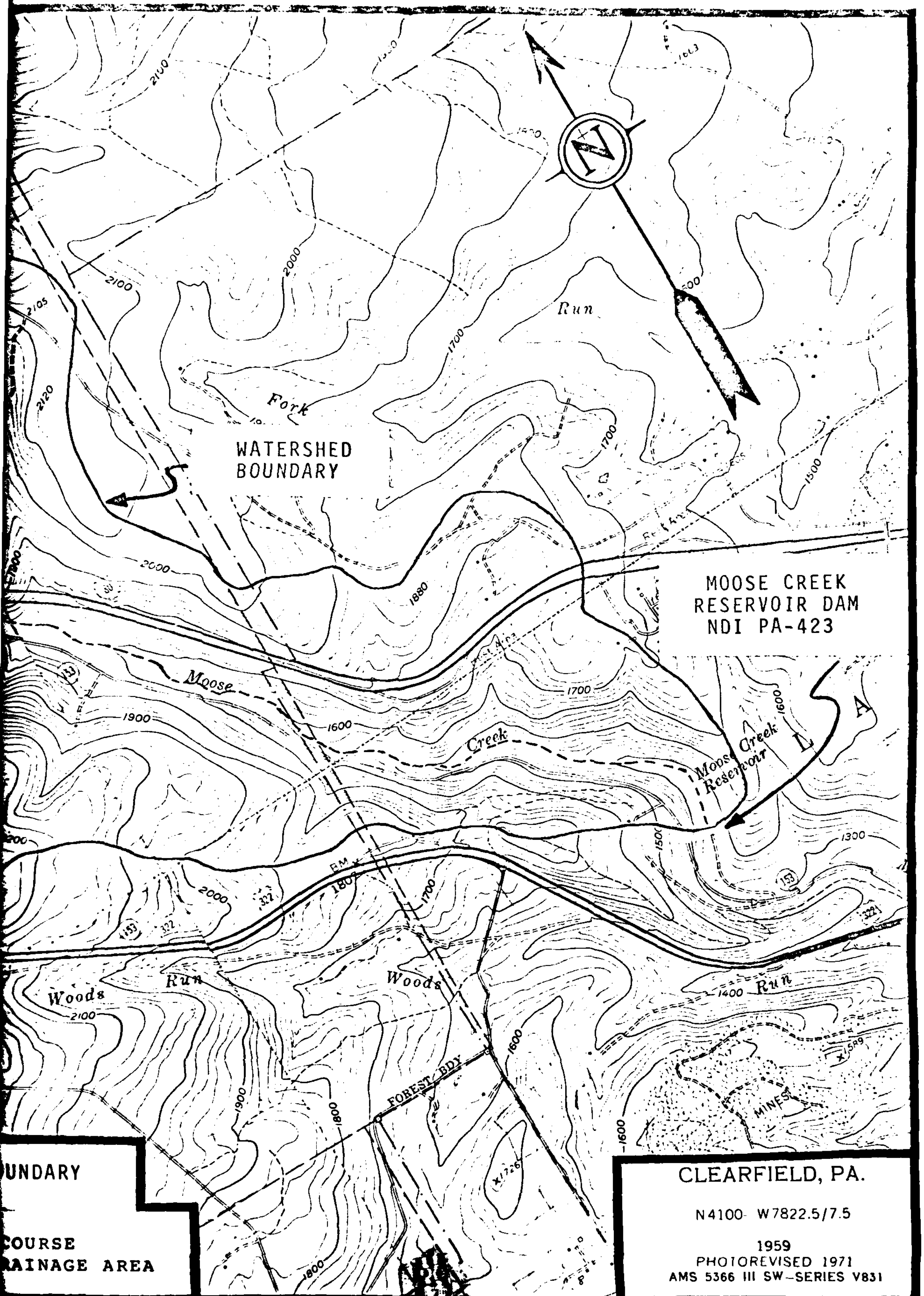
APPENDIX G

REGIONAL VICINITY AND WATERSHED BOUNDARY MAPS


Fork
Run
Moose
Creek
BM
1807
Woods
FOREST BDY
Moose Creek
Reservoir
MOOSE CREEK RESERVOIR DAM
Run
Moose
BM
1224
STRIP
MINES
Creek
PIKE
CLEARFIELD, PA.
1959
AMS 5366 III SW SERIES V831
REGIONAL VICINITY MAP



Hobo
Hill
Branch
Right
Moose
Creek
Branch
Left
2000
2300
1900
SCHOFIELD
DUBEC
HOLLOW
ELLIOTT PARK, PA
1959
WATERSHED BOUN
MAP
LONGEST WATERCOU
CENTROID OF DRAI


WATERSHED
BOUNDARY
MOOSE CREEK
RESERVOIR DAM
NDI PA-423
Fork
Run
Moose
Creek
Moose Creek
Reservoir
Woods
Run
Woods
Run
FOREST BDY
MINES
2100
2000
1900
1800
1700
1600
1500
1300
UNDARY
COURSE
RAINAGE AREA
CLEARFIELD, PA.
N4100- W7822.5/7.5
1959
PHOTOREVISED 1971
AMS 5366 III SW-SERIES V831